

Sustainable Health Care Cost Growth Target Program

How Oregon will implement statistical tests assessing whether health insurance carriers and provider organizations have met the 3.4% cost growth target

Background

Purpose of this document: Describe the statistical methods OHA will use to assess carriers and provider organizations against the health care cost growth target in order to hold these entities accountable. Note that accountability mechanisms have yet to be developed by the Implementation Committee. Provide examples of calculations.

Guidance from the Implementation Committee: Instead of choosing a minimum population a priori as other states have done, the Committee requested that OHA take a more statistically rigorous approach that will still include as many carriers and provider organizations as possible.

During the [October Implementation Committee meeting](#), OHA proposed the following thresholds and the Committee agreed that this is the right direction:

- A carrier or provider organization would be held accountable for performance against the cost growth target in any year if a difference can be detected at 95% confidence.
- A carrier or provider organization would be held accountable for performance against the cost growth target in the second year if a difference can be detected at 80% confidence for two consecutive years.
- If a carrier or provider organization demonstrates they have exceeded the cost growth target at 80% confidence in 3 out of 5 years, they would also be held accountable.
- No action would be taken in any years for carrier or provider organizations who appear to exceed the target, but we cannot detect a difference at 80% confidence

While not discussed with the Implementation Committee in October, future governance bodies may wish to also look at longer-term trends, such as cost growth over a five-year period, not just the year-over-year growth in each of those five years. This analysis will be important in future program years.

Intent

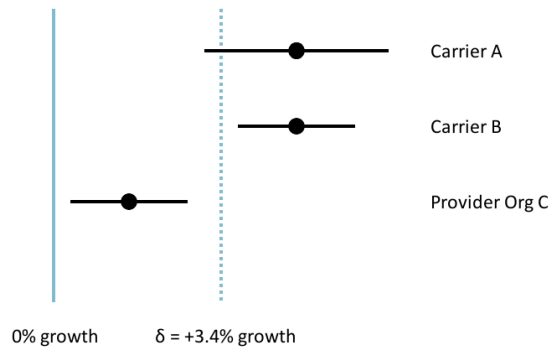
OHA wants to identify three categories of carriers and provider organizations:

	Analysis:	Designation:
1	Upper confidence interval is fully below the target	Achieved the target; positive recognition
2	Confidence interval intersects with the target	Unable to determine performance relative to the target with confidence, not subject to accountability
3	Lower confidence interval is over the target	Exceeded the target; may be subject to accountability mechanisms

This document presents the statistical methodology to assess confidence intervals. Many online resources provide an introduction to statistics and confidence intervals.¹

Example: Mean Per Member Per Month (PMPM) Costs between Year 1 and Year 2

The figure to the right shows three different cost growth amounts, signified by the black dot, and confidence intervals, represented by the horizontal lines to the immediate left and right of each black dot. As the graphic shows, Carrier A's mean PMPM cost from year 1 to year 2 grew by more than 3.4%. However, given the number of individuals (N) and the variance of Carrier A's member costs, the confidence interval is such that we **cannot** say that Carrier A exceeded the growth with 95% confidence.



Carrier B on the other hand exceeds the target with 95% confidence. Provider Organization C's mean PMPM cost growth is less than 3.4% and we can say they have achieved the cost target with 95% confidence.

Carrier A would not be subject to accountability mechanisms. Carrier B would be subject to accountability mechanisms. Provider C would be given positive recognition for achieving the target.

Statistical Testing

Methods: The growth of mean PMPM costs from one year to a second will be assessed with the ratio of year 2 divided by year 1. Using a ratio to test the null hypothesis:

$$H_0: \frac{\bar{X}_2}{\bar{X}_1} \leq \rho$$

According to the 3.4% cost growth target, $\rho = 1.034$, which suggests the result of dividing the second year's mean PMPM cost by the first year's mean PMPM is less than or equal to 1.034. This hypothesis can be re-written as:

$$H_0: \bar{X}_2 - \rho\bar{X}_1 \leq 0$$

In which the second year's mean PMPM cost minus the product of 1.034 and the first year's mean PMPM cost is less than or equal to zero.

¹ <https://www.khanacademy.org/math/statistics-probability>
<https://www.khanacademy.org/math/statistics-probability/confidence-intervals-one-sample>
<https://courses.lumenlearning.com/introstats1/chapter/introduction-confidence-intervals/>

To test the above hypotheses, we must calculate the confidence intervals at 95% and, when necessary, 80%. To calculate the confidence intervals, we must pool variances and there are two different formulae depending on whether the two variances are similar or not.

In summary, the percent cost growth from year one to year two is a ratio of two means. In other words, the average PMPM cost of year two divided by the average PMPM cost of year one, minus one, yields the percentage growth. If that growth exceeds 3.4% and is statistically significant at 95% or 80% confidence, then we can say that entity exceeded the cost growth target. The 95% confidence threshold will be used for year-to-year assessment, while the 80% confidence threshold will be used for assessing cost growth target achievement in two consecutive years and in three out of five years.

Calculating the confidence interval for the ratio of two means requires a version of Fieller’s theorem. We cannot, however, calculate covariance of paired measurements because we don’t have individual-level data and not all measurements will be paired. The formulae below allow us to apply Fieller’s approach calculating ratios without needing the covariances.

Formulae -

Notation Table	
i	Year index, 1 = prior year, 2 = current year
df	Degrees of freedom
N_i	Population size for year i (or number of member months for year i)
V_i	Variance for year i
σ_i	Standard deviation (when squared it equals variance)
\bar{X}_i	Mean PMPM cost for year i (population-level mean)
ρ	Growth target ratio

The original formula to calculate pooled variance from a sample is:

$$V_{\text{pool}} = \frac{1}{n_i - 1} \sum_{j=1}^{n_i} (y_j - \bar{y}_i)^2$$

However, the original formula requires individual-level data and cannot be used under our data collection framework. In addition, the data carriers will submit will represent a census, not a sample. We will use a population-based statistic to pool variances (or standard deviations):

$$\sigma_{\text{pool}} = \sqrt{\frac{\sum_i N_{X_i} \sigma_{X_i}^2}{\sum_i N_{X_i}} + \frac{\sum_{i < j} N_{X_i} N_{X_j} (\bar{X}_i - \bar{X}_j)^2}{(\sum_i N_{X_i})^2}}$$

Two sets of formulas are used depending on whether the variances of the two consecutive years are similar or not.

When the variances (or standard deviations) are similar

The formula for the degrees of freedom is

$$df = N_1 + N_2 - 2$$

Confidence interval:

$$CI = \frac{\bar{X}_1 \bar{X}_2 \pm \sqrt{\bar{X}_1^2 \bar{X}_2^2 - \left(\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V}{N_1}\right) \left(\bar{X}_2^2 - t_{df,\alpha}^2 \frac{V}{N_2}\right)}}{\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V}{N_1}}$$

where

$$V = \frac{V_1(N_1 - 1) + V_2(N_2 - 1)}{N_1 + N_2 - 2}$$

When the variances (or standard deviations) are different, which will be the most likely scenario

The formula for the degrees of freedom is

$$df = \frac{\left(\frac{V_2}{N_2} + \left(\frac{\bar{X}_2}{\bar{X}_1}\right)^2 \frac{V_1}{N_1}\right)^2}{\frac{V_2^2}{N(N_2 - 1)} + \frac{\left(\frac{\bar{X}_2}{\bar{X}_1}\right)^4 V_1^2}{n_1^2(N_1 - 1)}}$$

Confidence interval:

$$CI = \frac{\bar{X}_1 \bar{X}_2 \pm \sqrt{\bar{X}_1^2 \bar{X}_2^2 - \left(\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V_1}{N_1}\right) \left(\bar{X}_2^2 - t_{df,\alpha}^2 \frac{V_2}{N_2}\right)}}{\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V_1}{N_1}}$$

Testing equality of variance

To determine if the two variance values are similar, the OHA team will use a two-sided F-test at a significance level of 0.05:

$$F = \frac{\sigma_1^2}{\sigma_2^2}$$

Example using mock data

Each carrier will submit payment data for provider organizations stratified by line of business. To calculate the carrier's cost growth, OHA staff will use a weighted value to assess cost growth. Carriers will also submit a risk score for each row so that OHA staff can adjust the average PMPM spending to account for risk. Carriers will also submit risk adjusted standard deviation, which is described later in this document.

As an example, a carrier submits the following data to OHA:

For 2018

Paid entity	Line of Business	Average PMPM spending (risk-adjusted)	Member Months
Hospital System Z	Medicaid	\$416.67	240,000
Hospital System Z	Commercial	\$666.67	660,000
Main St Provider Group	Medicaid	\$66.67	93,000
Main St Provider Group	Commercial	\$83.33	384,000

For 2019

Paid entity	Line of Business	Average PMPM spending (risk-adjusted)	Members Months
Hospital System Z	Medicaid	\$458.33	204,000
Hospital System Z	Commercial	\$650.00	720,000
Main St Provider Group	Medicaid	\$70.83	72,000
Main St Provider Group	Commercial	\$175.00	480,000

From the carrier-submitted data, OHA can calculate weighted spending averages for each line of business in each year:

For 2018

	Line of Business	Average PMPM spending (risk-adjusted)	Members Months
Totals	Medicaid	\$318.92	333,000
Totals	Commercial	\$452.11	1,044,000

For 2019

	Line of Business	Average PMPM spending (risk-adjusted)	Members Months
Totals	Medicaid	\$357.25	276,000
Totals	Commercial	\$460.00	1,200,000

The weighted spending averages are calculated by multiplying the spending in each row by the number of member months, then summing the products, and then dividing the grand total by the total number of member months.

The carrier’s average PMPM spending for their Medicaid business in total grew by 12.0%, which is calculated by $[\$357.25/\$318.92 - 1]$.

The carrier’s average PMPM spending for their Commercial business grew by 1.7%, which is calculated by $[\$460.00/\$452.11 - 1]$.

The weighted PMPM spending in 2018 was \$419.90 and the weighted PMPM spending in 2019 was \$440.79. These values are weighted by the number of members. Therefore, the weighted growth for all of this carrier’s lines of business combined is 5.0%. This carrier has many more commercial lives than Medicaid lives, which is why the weighted average is closer to the commercial average of 1.7% than it is the Medicaid average of 12.0%.

Calculating confidence intervals:

In addition to the data described above, carriers will also have to submit the risk-adjusted standard deviation of the PMPM spending for each row.

For example, in the 2019 data the carrier above would have to calculate the total spent for each of the 204,000 Medicaid member months attributed to Hospital System Z and calculate the standard deviation on that distribution. Similarly, the carrier will need to analyze the 276,000 total Medicaid member months and calculate the standard deviation of the PMPM costs of that distribution.

For 2018

Paid entity	Line of Business	Average PMPM spending (risk-adjusted)	Member Months	Risk-adjusted standard deviation
Hospital System Z	Medicaid	\$416.67	240,000	\$166.67
Hospital System Z	Commercial	\$666.67	660,000	\$250.00
Main St Provider Group	Medicaid	\$66.67	93,000	\$29.17
Main St Provider Group	Commercial	\$83.33	384,000	\$39.58

For 2019

Paid entity	Line of Business	Average PMPM spending (risk-adjusted)	Members Months	Risk-adjusted standard deviation
Hospital System Z	Medicaid	\$458.33	204,000	\$166.67
Hospital System Z	Commercial	\$650.00	720,000	\$375.00
Main St Provider Group	Medicaid	\$70.83	72,000	\$41.67
Main St Provider Group	Commercial	\$175.00	480,000	\$56.25

OHA staff will use the risk-adjusted average PMPM spending, the number of member months, and the risk-adjusted standard deviation of the PMPM costs to calculate the confidence intervals, which will tell us if the growth rate is less than or greater than the cost growth target with 95% or 80% confidence – whichever alpha value is required for that situation.

We must pool standard deviations to calculate confidence intervals. This will apply when calculating:

- The weighted PMPM growth for a given carrier. In the example above, we must pool the standard deviations of the carrier’s Medicaid line of business and the commercial line of business.
- The aggregate PMPM growth for a provider organization whose data is listed in multiple carriers’ data submission. We must pool the standard deviations of all the rows that list Hospital System Z to determine whether that entity’s growth is less than or greater than the cost growth target with 95% or 80% confidence.
- The aggregate PMPM growth for the whole line of business. We must pool the standard deviations of all “Medicaid total” rows from all data submitters to determine if, as a whole, we achieved or exceeded the target in the Medicaid market statewide. OHA will replicate this for every line of business.

Note: after aggregating all data for a given line of business across the state, the confidence intervals will almost surely be very narrow due to the large number of member months. Therefore, pooling standard deviation (or variances) and calculating the confidence intervals at the market and state level may not be necessary, but we will do so regardless.

Technical Assistance to data submitters:

OHA will provide technical assistance and guidance to carriers submitting data. Topics will include how to prepare data before calculating standard deviation, calculating the standard deviation, and how to report values in the template.

Example Calculations for Confidence Intervals

Example calculations use the initial health care cost growth target of 3.4%.

Calculations for each year

Using the example data above, we first must calculate the pooled standard deviation for each year, for each line of business using the pooled standard deviation equation:

$$\sigma_{pool} = \sqrt{\frac{n_1\sigma_1^2 + n_2\sigma_2^2}{n_1 + n_2} + \frac{n_1 n_2}{(n_1 + n_2)^2}(\bar{X}_1 - \bar{X}_2)^2}$$

First section Second section

For 2018 Medicaid first section:

$$= [(240,000 * 166.67^2) + (93,000 * 29.17^2)] / (240,000 + 93,000) = 20,258.46$$

2018 Medicaid second section:

$$= (240,000 * 93,000) / (240,000 + 93,000)^2 * (416.67 - 66.67)^2 = 24,657.09$$

2018 Medicaid all sections together:

$$= \sqrt{(20,258.46 + 24,657.09)} = 211.93$$

For 2018 Commercial first section:

$$= [(660,000 * 250.00^2) + (384,000 * 39.58^2)] / (660,000 + 384,000) = 40,087.71$$

2018 Commercial second section:

$$= (660,000 * 384,000) / (660,000 + 384,000)^2 * (666.67 - 83.33)^2 = 79,125.72$$

2018 Commercial all sections together:

$$= \sqrt{(40,087.71 + 79,125.72)} = 345.27$$

For 2018

Paid entity	Line of Business	Average PMPM spending (risk-adjusted)	Member Months	Pooled Risk-adjusted standard deviation
Total	Medicaid	\$318.92	333,000	\$211.93
Total	Commercial	\$452.11	1,044,000	\$345.27

Next, we pool the values again to calculate the pooled risk-adjusted standard deviation across all lines of business in 2018. Using the same steps above the pooled risk-adjusted standard deviation for 2018 is 323.26.

Calculations for growth over both years

Now that we have the carrier's pooled standard deviations for all lines of business in each year, we can calculate the confidence intervals of the growth of the mean PMPM spending amounts.

We already calculated the following:

	Weighted PMPM average	Pooled SD	Sample size (total members)
2018	\$419.90	323.26	1,377,000
2019	\$440.79	352.98	1,476,000

Calculating confidence intervals

The weighted growth from \$419.90 to \$440.79 is 5.0%. Now we apply the statistical test to assess the confidence intervals to see if the carrier exceeded the target with 95% confidence. We can calculate the confidence intervals for unequal variances by using the formula:

$$CI = \frac{\bar{X}_1 \bar{X}_2 \pm \sqrt{\bar{X}_1^2 \bar{X}_2^2 - \left(\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V_1}{n_1}\right) \left(\bar{X}_2^2 - t_{df,\alpha}^2 \frac{V_2}{n_2}\right)}}{\bar{X}_1^2 - t_{df,\alpha}^2 \frac{V_1}{n_1}}$$

Where $t_{df,\alpha}$ equals the t-statistic given the degrees of freedom (df) and the value of alpha (α). For 95% confidence, the alpha value is 0.05, which means:

$$t_{df,0.05} = 1.644861 \text{ (when using a one-sided test)}^2$$

For 80% confidence, the alpha value is 0.20, which means:

$$t_{df,0.20} = 0.841623 \text{ (when using a one-sided test)}$$

For 95% confidence, the upper and lower estimates are calculated as follows:

Numerator:

$$= (419.90 * 440.79) \pm \sqrt{[419.90^2 * 440.79^2 - (419.90^2 - 1.644861 * (323.26^2 / 1,377,000)) * (440.79^2 - 1.644861 * (352.98^2 / 4,476,000))]}$$

$$= 185,085.9 \pm 283.1259398$$

Denominator:

$$= 419.90^2 - 1.644861^2 * (323.26^2 / 1,377,000) = 176,315.64$$

Upper estimate:

$$= (185,085.9 + 283.1259398) / 176,315.64 = \mathbf{1.051348}$$

Lower estimate:

$$= (185,085.9 - 283.1259398) / 176,315.64 = \mathbf{1.048136}$$

The weighted growth rate from year 1 to year 2 was 5.0%, as calculated before and the 95% confidence interval range is 4.81%, which is the rounded percent value of the calculated lower estimate of 1.048136, and 5.13%, which is the rounded percent value of the calculated upper estimate of 1.051348.

² For the complete list of statistical tables: <https://onlinelibrary.wiley.com/doi/pdf/10.1002/0471733199.app1>

Therefore, we can say with 95% confidence that this carrier across all lines of businesses exceeded the cost growth target of 3.4%. This example of a carrier exceeding the cost growth target with 95% confidence matches the abstract example presented as “carrier B” at the beginning of this document.

The same methodology can be used to calculate each line of business for a given carrier.

Calculating provider organizations’ growth rates

A similar approach can be used to calculate a provider organization’s growth rate. To calculate a provider organization’s growth and apply confidence intervals, we first must pool variances across all carriers within a given line of business and then pool variances again across the lines of business.

After pooling the multiple levels, we then assess confidence levels at 95% and 80% using the formulae outlined above.

References

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