

Target-Setting Methods in Healthy People 2030

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Abstract

Introduction—Healthy People is an initiative of the U.S. Department of Health and Human Services that provides science-based, 10-year national objectives and targets for improving the health of all Americans. The fifth iteration of the initiative, Healthy People 2030 (HP2030), was released in August 2020. As in previous iterations, targets were set with the goal to be achieved by the end of the decade. HP2030 aims for continued transparency and scientific basis for how targets are selected and justified. To this end, the National Center for Health Statistics (NCHS) developed statistical methods and analytical tools to assist in setting transparent, data-driven targets.

Objective—This Statistical Note documents the statistical methods underlying the analytical tools that were

developed by NCHS for HP2030 target setting based on percent or percentage point improvement and trend projection.

Targets based on percent or percentage point improvement—In HP2030, targets reflecting a projected 10- or 20-percent improvement from baseline values are proposed for rates and quantities other than percentages. For percentages, NCHS developed an enhanced method for HP2030, based on a percentage point improvement derived from Cohen's effect size h . When applicable, two effect size values are proposed, $h = 0.1$ and $h = 0.2$.

Targets based on trend projection—When historical data are available, fitting a trend line using (weighted) least squares permits the calculation of a range of predictions for the value of

an indicator at any future time point. From this range of predictions, users can select a target based on the objective's desired direction (i.e., increase or decrease).

Conclusion—HP2030 is the first decade in the Healthy People initiative in which analytical tools for setting targets have been developed by NCHS. These tools assist in setting transparent, data-driven targets, and the methodological underpinnings of these tools may be useful for other public health initiatives.

Keywords: Healthy People objectives • target-setting methodology • directional effect size • trend analysis

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Introduction

Healthy People is an initiative of the U.S. Department of Health and Human Services (HHS) that establishes national goals and measurable objectives with 10-year targets to guide evidence-based policies, programs, and other actions to improve the health and well-being of all Americans. HHS's office of Disease Prevention and Health Promotion (ODPHP) manages Healthy People in collaboration with a diverse



group of stakeholders, partners, and organizations. The fifth decade of the initiative, Healthy People 2030 (HP2030), launched in August 2020 (1). The inclusion of quantifiable, 10-year targets has distinguished Healthy People from the many federal health indicator initiatives that have been developed in the past four decades (for example, 2–4). The examination of data relative to targets is considered critical to the usefulness of Healthy People, as targets communicate policy expectations and expert or evidence-based recommendations to a wide range of stakeholders. In addition to serving as markers of progress for individual objectives, targets also offer benchmarks for assessing progress for the initiative.

At the beginning of each decade, targets are set by topic area workgroups comprised of policy and subject matter experts, mostly from federal agencies. Healthy People targets reflect subject matter, policy, and political considerations and are therefore, not strictly statistical constructs. The role of the National Center for Health Statistics (NCHS) in target setting over the decades has been to provide technical assistance on statistical and data-related matters, promote consistency in target-setting approaches, and measure progress across topic areas throughout the decade, specifically at each decade's midcourse and final reviews (for example, 5,6); for more information, see the “Role of NCHS in Healthy People” section. For the HP2030 decade, NCHS developed statistical methods and analytical tools (7) to assist topic area workgroups in their deliberations to set more transparent, data-driven targets. The final selection of targets is done by the topic area workgroups using their subject matter expertise. The topic area workgroup may consider public health policies and agency priorities when selecting a target.

Role of NCHS in Healthy People

NCHS has been involved in multiple aspects of the Healthy People initiative. NCHS staff serve as statistical advisors to ODPHP and the topic area workgroups on health promotion data; engage in research and development of methods to assist the topic area workgroups in setting targets and measuring the overarching goals of Healthy People (e.g., eliminating health disparities); conceptualize and produce analytical and graphical presentations to display progress towards reaching the goals and objectives, including midcourse and final review publications; maintain a comprehensive database for all the Healthy People objectives; and provide expertise and technical assistance to national, state, and local health monitoring efforts.

Past approaches to target setting

In the first decade of Healthy People, launched in 1979 with targets to be reached by 1990, no systematic process existed for target setting across objectives. In Healthy People 2000 (HP2000), again no systematic process was used for

target setting, but for selected population-based objectives, targets for high-risk subgroups were set to achieve a greater percent improvement than for the total population, which was concordant with the HP2000 overarching goal to reduce health disparities. For Healthy People 2010 (HP2010), target setting evolved into a more systematic and consistent process. To reflect the HP2010's overarching goal of eliminating health disparities, targets for most population-based objectives were set at a level that was at least one unit (e.g., one percentage point, 1 per 1,000 persons, 1 microgram, etc.) better than the best racial or ethnic group rate. This method was referred to as “better-than-the-best” and applied to the total population and most demographic subgroups (8). Other target-setting methods used in HP2010 were: percent improvement, total elimination or total coverage, consistency with a national program or policy, projection, retention of the HP2000 target, and maintain the HP2010 baseline value.

For Healthy People 2020 (HP2020), target-setting methods were modified to strive for consistency and a more scientific basis for how targets were set across objectives, as well as more realistic targets. In previous decades, targets were typically very challenging, and generally less than 25% of targets were achieved by the end of the decade. In addition, few topic area workgroups used evidence- or science-based target-setting methods. For HP2020, workgroups were encouraged to use evidence- or science-based target-setting methods (such as modeling or trend projection) whenever possible, and a standard default method of 10-percent improvement (a figure derived based on analysis by NCHS, as described in the “Transition from HP2020 to HP2030 target-setting methods” section) was adopted when circumstances did not permit the use of evidence- or science-based methods (5,9). Other target-setting methods were also available for topic area workgroups to use, including specific percentage point improvement; consistency with national programs, regulations, policies, and laws; total coverage or elimination; modeling; projection and trend analysis; minimal statistical significance; maintain the HP2020 baseline; and retention of HP2010 target. For the HP2020 tracking period, the targets were met for 31.7% of the measurable HP2020 objectives (Table 1), which is generally higher than the percentage achieved in previous decades.

HP2030 target-setting approaches

Supported by requests from stakeholders and recommendations from the HHS Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2030 (Committee), a federal advisory committee composed of nonfederal, independent subject matter experts, HP2030 aims for continued transparency and a more systematic approach for how targets are selected, compared with previous decades, allowing for replication of target-setting methodology (e.g., at the state and

Table 1. Summary of measurable HP2020 objectives by target-setting method

Target-setting method	Number of objectives	Percent of total	Targets met ¹	Percent of targets met ¹
10% improvement	649	61.5	247	38.1
Specific percentage point improvement	30	2.8	12	40.0
Consistency with national programs, regulations, policies, or laws; or total coverage or elimination	194	18.4	36	18.6
Modeling or projection and trend analysis	97	9.2	21	21.6
Minimal statistical significance	62	5.9	12	19.4
Maintain baseline	13	1.2	4	30.8
Retention of HP2010 target	11	1.0	3	27.3
Total	1,056	100.0	335	31.7

¹As of January 2020. Changes may be possible on HP2020 tracking data until the HP2020 Final Review is published in 2021.

SOURCE: National Center for Health Statistics, Healthy People 2030 database.

local levels) (10). The HP2030 target-setting methods (TSMs) allow for targets to be considered using data-driven decision points and include:

- percent or percentage point improvement;
- projection (e.g., trend projection);
- minimal statistical significance;
- consistency with national programs, regulations, policies, or laws; and
- maintain the HP2020 baseline value.

This Statistical Note describes the statistical methods underlying the analytical tools that were developed by NCHS to support topic area workgroups in their selection of HP2030 targets based on percent or percentage point improvement and trend projection (7). The methodology for the minimal statistical significance TSM for HP2030 is unchanged from HP2020 and is discussed in the Appendix. No analytical tools were developed by NCHS for TSMs that were based on consistency with national programs, regulations, policies, or laws, or maintaining the baseline value.

Development of HP2030 objectives and targets

As of the launch of HP2030 in August 2020, there were 355 core objectives (previously referred to as measurable objectives, which are objectives with baseline values). As in the past, proposed objectives were initially drafted by topic area workgroups and were reviewed by the Federal Interagency Workgroup (FIW), the steering committee for Healthy People. The objectives were then made available for public comment from December 2018 to January 2019, before final objectives were approved by HHS leadership. NCHS developed statistical methods and analytical tools and provided guidance to the topic area workgroups to assist in developing data-driven targets for the core HP2030 objectives. Concurrent with the public comment period for proposed objectives, topic area workgroups proposed HP2030 targets

from December 2018 to February 2019. All proposed HP2030 objectives along with their targets were reviewed by the FIW and approved by HHS before they were finalized.

Secretary’s Advisory Committee’s recommendations for HP2030 target setting

The recommendations of the Committee to guide HP2030 target setting were finalized in July 2018 (9). The Committee recommended that a science-based approach to setting targets for HP2030 be supported by transparent methods for target identification and justification and that targets represent a meaningful and achievable change. The Committee also recommended that selected TSMs from prior decades of Healthy People be prioritized for use in HP2030 based on their scientific basis and ability to support the assessment of target achievability. “Modeling and/or projection/trend analysis” was given the highest priority for target setting (9).

Transition from HP2020 to HP2030 target-setting methods

In HP2020, targets were set using science-based methods whenever possible; however, the majority of HP2020 objectives, 61.5%, used a 10-percent improvement TSM (Table 1). The FIW arrived at this method after NCHS performed an analysis of HP2010 objectives using a range of percent improvement values and projected the percentage of objectives that would have met their targets by the end of the HP2010 decade for each percent improvement value. Based on this analysis, the FIW chose a 10-percent improvement as the default method for HP2020, as it would have resulted in approximately 50% of objectives meeting their targets by the end of the HP2010 decade. No justification was required when this method was used.

HP2030 aims to be more transparent about the topic area workgroup’s rationale for the appropriateness of selected targets. NCHS and ODPHP collaborated to create guidelines

for topic area workgroups to use when selecting data-driven targets. The TSM and TSM justification is required for every core HP2030 objective and will be published on the Healthy People website, allowing for better understanding and replicability of these TSMs by others. To ensure transparency, retention of the prior decade’s targets is no longer used as a TSM in HP2030. In addition, data-driven approaches, such as modeling or projection and trend analysis, are prioritized when available in HP2030. To help ensure additional transparency and consistency in the HP2030 target-setting process, a flowchart was created to assist topic area workgroups with the selection of a TSM (Figure 1). To learn more about the flowchart’s role in the HP2030 target-setting process, see the “Determining the best HP2030 target-setting method” section.

HP2030 target-setting methods

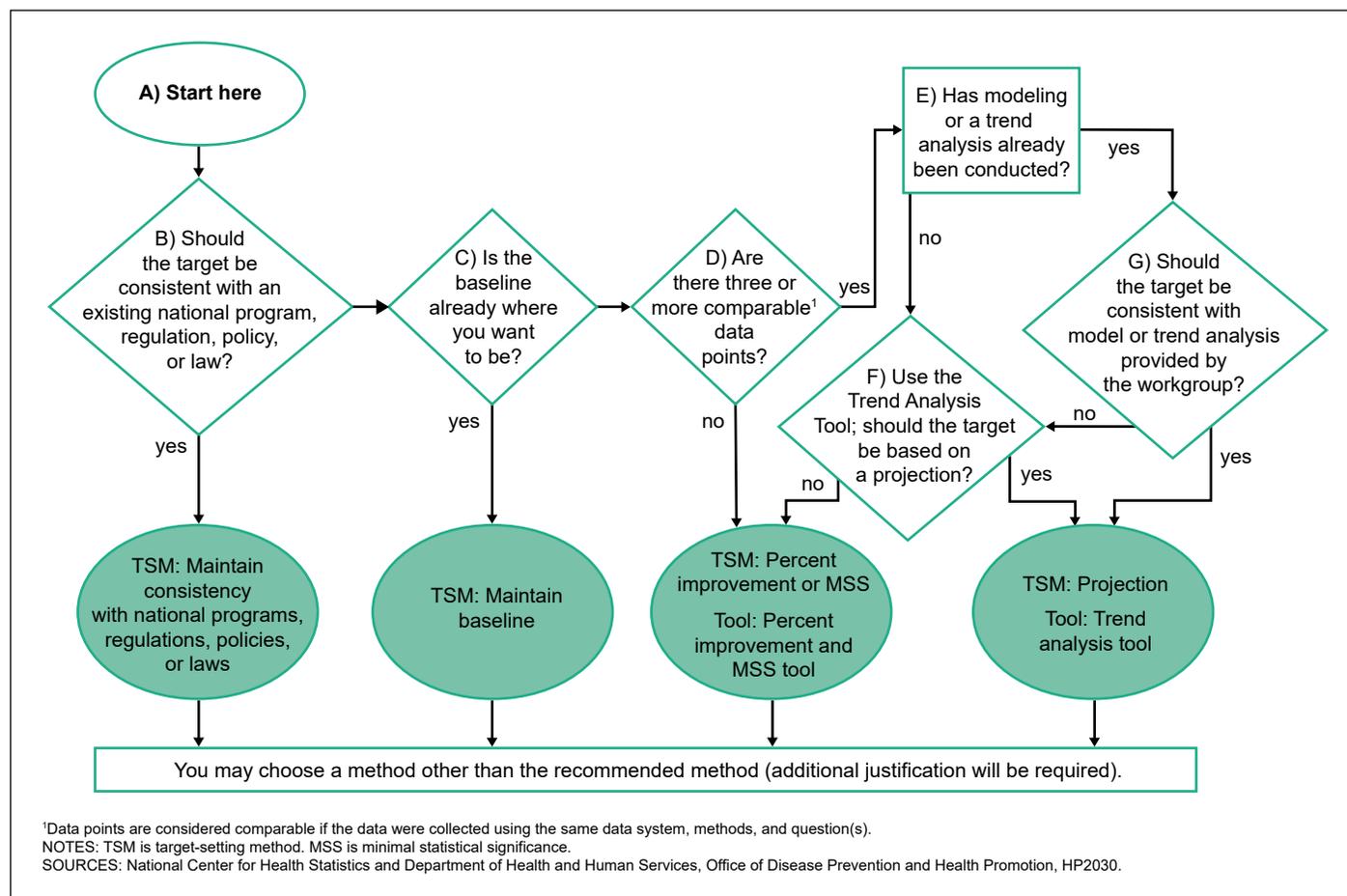
This section describes the TSMs used in HP2030, as well as examples of how the TSMs were applied.

Percent or percentage point improvement

While historical data and past trends can inform the selection of an appropriate percent or percentage point improvement from baseline for a given objective, only the baseline value is used to calculate a target based on a percent or percentage point improvement; the baseline standard error (SE) is not required, rendering these TSMs appealing for their simplicity. For a percent improvement, the baseline is multiplied by a specified percentage (e.g., 10%) and that value is added to or subtracted from the baseline, depending on the desired direction. For a percentage point improvement, the baseline (itself a percentage) is improved by adding or subtracting a specified value (e.g., 2), also known as a percentage point, depending on the desired direction.

Among HP2020 TSMs, the 10-percent improvement TSM had the largest proportion of targets that were met (Table 1). NCHS analysis of HP2020 data, not shown here, revealed that for objectives with a desired increase, 60% with baseline values in the 10%–20% range demonstrated a 10% increase from baseline, compared with just 5% of those with baseline values in the 80%–90% range (regardless of their

Figure 1. Healthy People 2030: Target-setting method selection



actual TSMs). To address this limitation in selecting targets for percentages, NCHS developed an enhanced method for HP2030, based on a percentage point improvement that is derived from a simple and transparent effect size calculation. Because the percent improvement TSM will remain an important tool for selecting targets in HP2030 for rates and other quantities, NCHS developed a Microsoft Excel-based calculator to estimate both the percent and percentage point improvement TSMs for HP2030 and the identification of possible targets (7), as described in the “HP2030 methodology for selected target-setting methods” section.

As of the launch of HP2030, 13% of targets were set based on percent improvement and 28% were based on percentage point improvement (Table 2). For example:

- HP2030 objective HDS–03, which tracks the stroke death rate, has a target of 33.4 per 100,000 population based on a 10-percent improvement from the baseline value of 37.1 per 100,000 population in 2018.
- HP2030 objective TU–01, which tracks current use of any tobacco products by adults, has a target of 16.2% based on an effect size of 0.1 or a 3.9 percentage point improvement from the baseline value of 20.1% in 2018.

Projection

As stated in the “Federal Advisory Committee’s recommendations for HP2030 target-setting” section projection is given the highest TSM priority among the recommended data-driven TSMs for HP2030. The projection TSM can be based on statistical models or trend analysis, or both. Trend analysis involves examining historical data to determine a trend that can be projected into the future. Statistical models can be used to predict a future outcome using additional input data. Models can incorporate historical data points, covariates, contextual information, and computer simulations.

Table 2. Summary of core HP2030 objectives by target-setting method as of August 2020

Target-setting method	Number of objectives	Percent of total
Percent improvement	47	13.2
Percentage point improvement	98	27.6
Projection	86	24.2
Minimal statistical significance	89	25.1
Consistency with national programs, regulations, policies, or laws	23	6.5
Maintain baseline	12	3.4
Total	355	100.0

SOURCE: National Center for Health Statistics, Healthy People 2030 database.

The projection TSM requires considerable analytic and methodological efforts, for which only a handful of topic area workgroups have the adequate resources. To assist all HP2030 topic area workgroups in their target-setting deliberations, NCHS developed a Microsoft Excel-based trend analysis calculator to facilitate the implementation of the projection TSM and the identification of possible targets (7). Due to the varying types of data sources and indicators in HP2030, NCHS focused exclusively on developing a tool for projection based on linear trend analysis; for more information, see “HP2030 targets based on trend projection.” Topic area workgroups were given the option to use other model- or simulation-based tools for projecting a future target value. Although, these model- and simulation-based methods are not covered in this Statistical Note, the TSM details and justification will be required and published on the Healthy People website after the launch of HP2030.

As of the launch of HP2030, 24% of targets were set based on projection (Table 2). For example:

- HP2030 objective AHS–02, which tracks the proportion of persons with dental insurance, has a target of 59.8% based on a projection using weighted least squares linear regression. The HP2030 baseline for this objective was 54.4% in 2018.
- HP2030 objective OSH–06, which tracks new cases of occupational hearing loss, has a target of 1.4 per 10,000 based on a projection using a decaying double exponential model. The HP2030 baseline for this objective was 1.7 per 10,000 in 2016.

Minimal statistical significance

As with the TSM based on percent or percentage point improvement, minimal statistical significance can also be used when historical data are not available for a trend projection analysis. However, both the baseline value and its SE are needed to calculate a target that, when met or exceeded, would represent a minimal statistically significant change from baseline (at the 0.05 level of significance).

As of the launch of HP2030, 25% of targets were set based on this TSM (Table 2). For example:

HP2030 objective D–01, which tracks the annual number of new cases of diagnosed diabetes, has a target of 5.6 per 1,000 based on a (minimal) statistically significant improvement from the baseline of 6.5 in 2016–18, assuming the same SE for the target as for the baseline.

Consistency with national programs, regulations, policies, or laws

The TSM of maintaining consistency with national programs, regulations, policies, or laws allows topic area workgroups to take federal agency programs and policies

into consideration, or to align with statistical analyses, including modeling or trend projections, conducted by their agencies. In HP2030, total coverage or elimination TSMs are designated together with the TSM of maintaining consistency with national programs, regulations, policies, or laws. TSM justifications continue to state the rationale for setting specific HP2030 targets based on this TSM.

As of the launch of HP2030, 7% of targets were set based on this TSM (Table 2). For example:

HP2030 objective CKD–07, which tracks new cases of end-stage kidney disease, has a target of 268.6 per 1,000,000 population for consistency with HHS’s Advancing American Kidney Health (2019). The HP2030 baseline was 358.1 per 1,000,000 in 2016.

Maintain baseline value as target value

The maintain baseline TSM may be utilized by the topic area workgroup because the objective is already at a desired level nationally, or because the objective is moving or expected to move in an undesirable direction.

As of the launch of HP2030, 3% of targets were set based on this TSM (Table 2). For example:

HP2030 objective IID–03, which tracks the vaccination coverage level of 1 dose of the measles-mumps-rubella vaccine among children by age 2 years, has a target of 90.8%, which is based on maintaining the HP2030 baseline of 90.8% in 2015.

Determining the best HP2030 target-setting method

As previously mentioned in the “Transition from HP2020 to HP2030 target-setting methods” section, NCHS aided ODPHP in creating a flowchart to help assist workgroups in selecting the best TSM for an objective in HP2030 (Figure 1). The flowchart was designed to ensure national programs, regulations, policies, or laws are considered when setting targets, and when historical data are available (3 or more data points) a trend analysis is conducted. Similar to HP2020, when historical data are not available or are unreliable, the recommended TSM is a percent or percentage point improvement. The flowchart provides recommendations and a systematic thought process for selecting a target, but ultimately the final TSM selection is the decision of the topic area workgroup.

HP2030 methodology for selected target-setting methods

This section describes the methodology developed by NCHS for setting HP2030 targets based on percent or

percentage point improvement and trend projection. Note that the HP2030 methodology for implementing the minimal statistical significance TSM is unchanged from HP2020 and is described in the Appendix.

HP2030 targets based on percent or percentage point improvement from baseline

As described in “Percent and Percentage Point Improvement,” after reviewing progress made by HP2020 objectives, NCHS developed an enhanced method for HP2030, based on a percentage point improvement that is derived from a simple and transparent effect size calculation. Figure 2a and 2b illustrate the disadvantage of using a percent improvement to set targets when the objective is measured using a percentage. As the baseline approaches 100, the targets get further away from the baseline. For example, if the TSM is a 10-percent improvement and the baseline is 90%, the targeted change would be 9 percentage points, while a baseline of 10% would only have a targeted change of 1 percentage point.

For HP2030 objectives that are measured using rates and quantities other than percentages, a 10-percent improvement was retained as a TSM option, and a TSM of 20-percent improvement was added as an additional option for topic area workgroups to consider.

Calculating the percentage point improvement for percentages in HP2030

The percentage point improvement for percentages in HP2030 is determined using a directional effect size calculation. Targets for percentages are calculated using Cohen’s *h* effect size, as follows (11).

Step 1. The baseline percent value is divided by 100 to obtain a proportion p_B and converted to the arcsine square root scale using:

$$\phi_B = 2 \arcsin \sqrt{p_B}$$

Step 2. Cohen’s *h* directional effect size is a change from the baseline value on this arcsine square root scale. The transformed target value Φ_T is calculated using:

$$\phi_T = \phi_B + h, \text{ if desired direction is an increase}$$

$$\phi_T = \phi_B - h, \text{ if desired direction is a decrease}$$

Step 3. The target proportion p_T is obtained by reverse transformation and multiplied by 100 to express it as a percentage:

$$p_T = \left(\sin\left(\frac{\phi_T}{2}\right) \right)^2$$

Figure 2a. Target setting for percentages using percent improvement from baseline when the desired direction is an increase

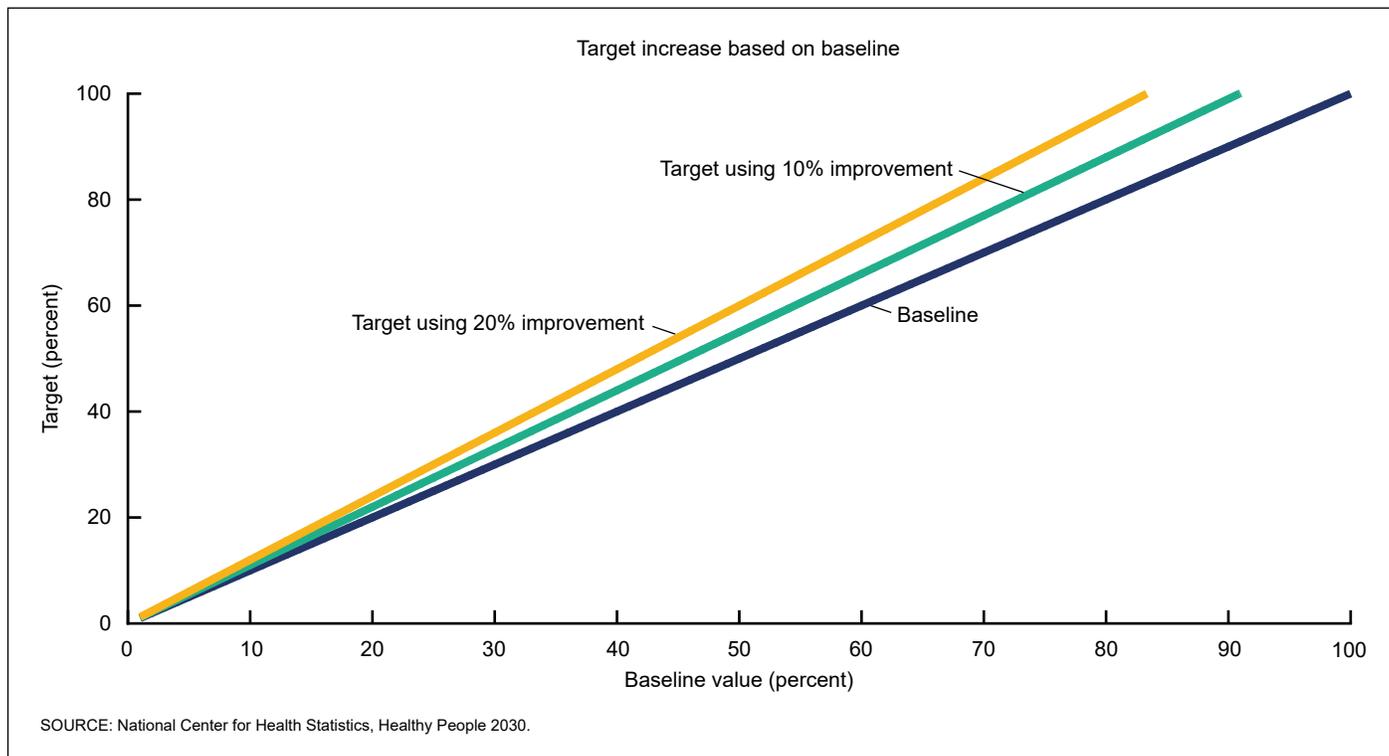
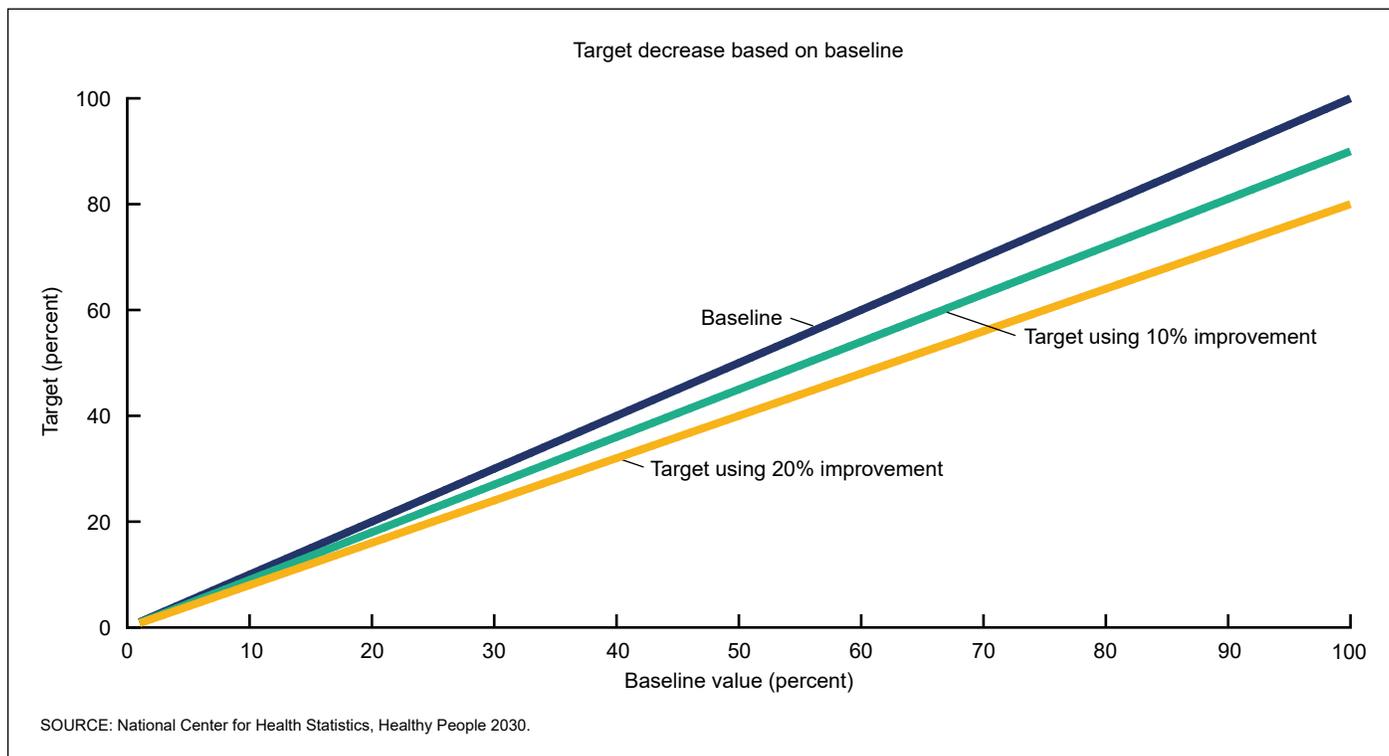


Figure 2b. Target setting for percentages using percent improvement from baseline when the desired direction is a decrease



Any effect size h could be chosen, though large effect sizes may be unrealistic and unachievable. Cohen provides some preliminary guidance regarding the interpretation of the effect size h , with 0.2 indicating a “small,” 0.5 a “medium,” and 0.8 a “large” effect size, but cautions against applying these qualifiers without reference to the subject matter.

For HP2030, NCHS provided two effect size values in setting targets, $h = 0.1$ and $h = 0.2$ for stakeholders to consider. These two effect size values were chosen to correspond with 10% and 20% improvement from a baseline of 50%.

Targets based on effect size of 0.1

For percentages, when the target is set based on a directional effect size of $h = 0.1$, the result is a 1–5 percentage point improvement from baseline, depending on the value at baseline:

- For baseline values in the range 25%–75%, the targeted change is 4–5 percentage points. Note that for baseline values around 50%, a targeted change of 5 percentage points corresponds to a 10% change from baseline.
- For baseline values in the ranges 10%–24% or 76%–90%, the targeted change is 3–4 percentage points.
- For baseline values in the ranges 1%–9% or 91%–99%, the targeted change is 1–3 percentage points.
- For baseline values near 0% or 100%, this method results in no targeted change (0 percentage points).

Figure 3a–3b show the relationship between the baseline value (dark blue line) and the target value based on an effect size of 0.1 (light blue line). The benefit of using this method over the 10-percent improvement TSM is that the difference between the baseline value and the target value is nearly symmetric around 50%. That is, the percentage point increase or decrease is the same for a baseline of 10% and a baseline of 90% (± 3 percentage points).

Targets based on effect size of 0.2

When the target is set based on a directional effect size of $h = 0.2$, the result is a 1–10 percentage point improvement from baseline, depending on the value at baseline:

- For baseline values in the range 25%–75%, the targeted change is 8–10 percentage points. Note that for baseline values around 50%, a targeted change of 10 percentage points corresponds to a 20% change from baseline.
- For baseline values in the ranges 10%–24% or 76%–90%, the targeted change is 5–9 percentage points.
- For baseline values in the ranges 1%–9% or 91%–99%, the targeted change is 1–7 percentage points.

- For baseline values that are near 0% or 100%, the targeted change is 0–1 percentage points.

Figure 3a–3b show the relationship between the baseline value (dark blue line) and the target value based on an effect size of 0.2 (green line). Similar to the effect size of 0.1, the difference between the baseline value and the target value is approximately symmetric. The effect size of 0.2 is nearly symmetric around 45% when an increase is desired (Figure 3a) and 55% when a decrease is desired (Figure 3b). That is, the percentage point increase is the same for a baseline of 10% and a baseline of 80% (7 percentage points) and a percentage point decrease is the same for a baseline of 20% and a baseline of 90% (–7 percentage points).

Considerations of target setting using percent or percentage point improvement

1. A directional effect size of $h = 0.2$ is “small” according to Cohen’s common language effect size (10). However, when measured on the relative (percent) scale, this can result in a substantially large targeted change for percentages. For example, $h = 0.2$ leads to increases of over 20% from baseline for baseline values under 49%, and over 100% for values under 6%. It can lead to decreases of more than 20% for baseline values under 48%, and more than 70% for values under 5%.
2. An effect size of $h = 0.1$ is more moderate. For example, it can result in increases of over 10% for baseline values under 48%, and over 50% for values under 5%. It can result in decreases of more than 10% for values under 48%, and more than 40% for values under 5%.
3. The directional effect size anchors the targeted change to a maximum absolute change from baseline instead of a relative (percent) change, resulting in up to 5 percentage points change for $h = 0.1$ and 10 percentage points for $h = 0.2$. See Figure 3a–3b.
4. When baseline values are less than 0.0625% and the desired direction is a decrease, the effect size of $h = 0.1$ results in targets that are not an improvement from the baseline and should not be used. When baseline values are greater than 99.9375% and the desired direction is an increase, the effect size of $h = 0.1$ results in targets that are not an improvement from the baseline and should not be used.
5. When baseline values are less than 0.25% and the desired direction is a decrease, the effect size of $h = 0.2$ results in targets that are not an improvement from the baseline and should not be used. When baseline values are greater than 99.75% and the desired direction is an increase, the effect size of $h = 0.2$ results in targets that are not an improvement from the baseline and should not be used.
6. Effect size does not take into account subject matter knowledge.

Figure 3a. Target setting for percentages using a directional effect size from baseline when the desired direction is an increase

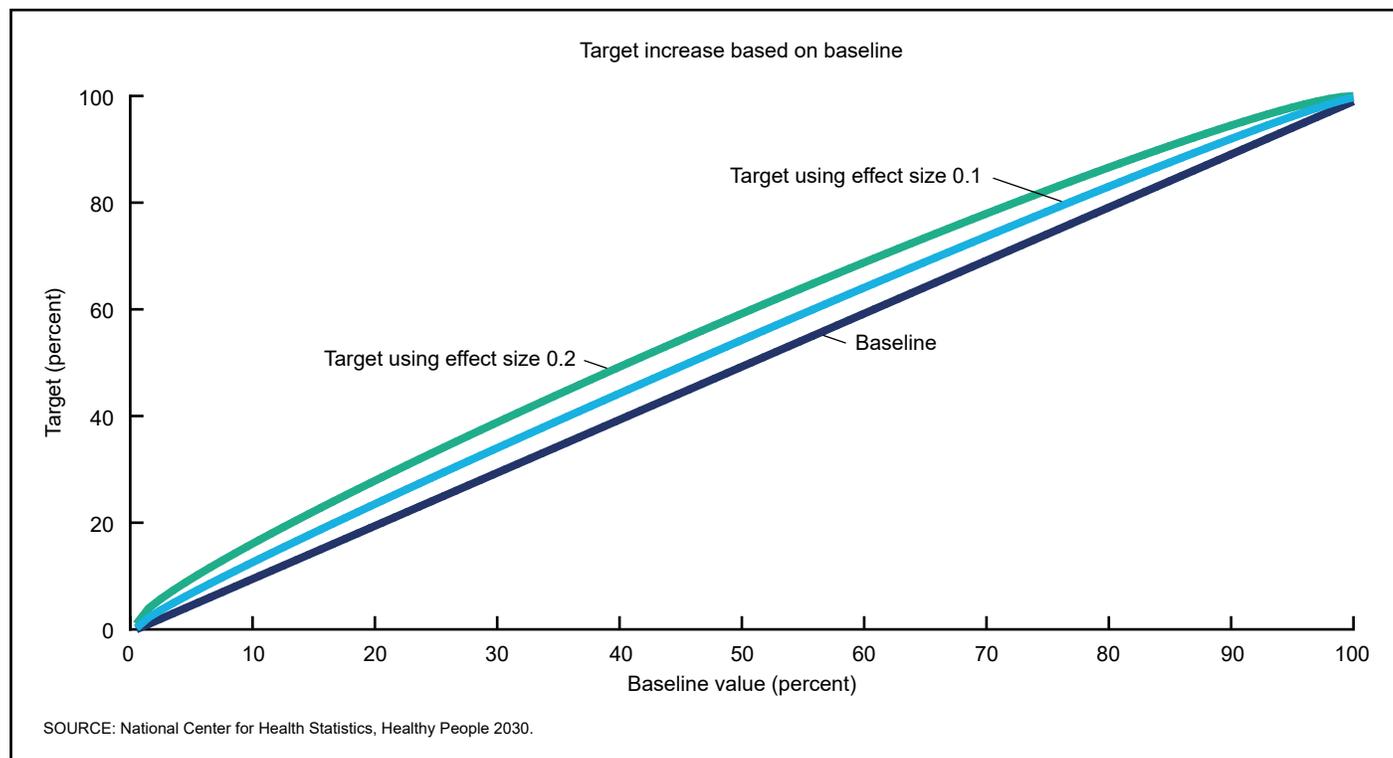
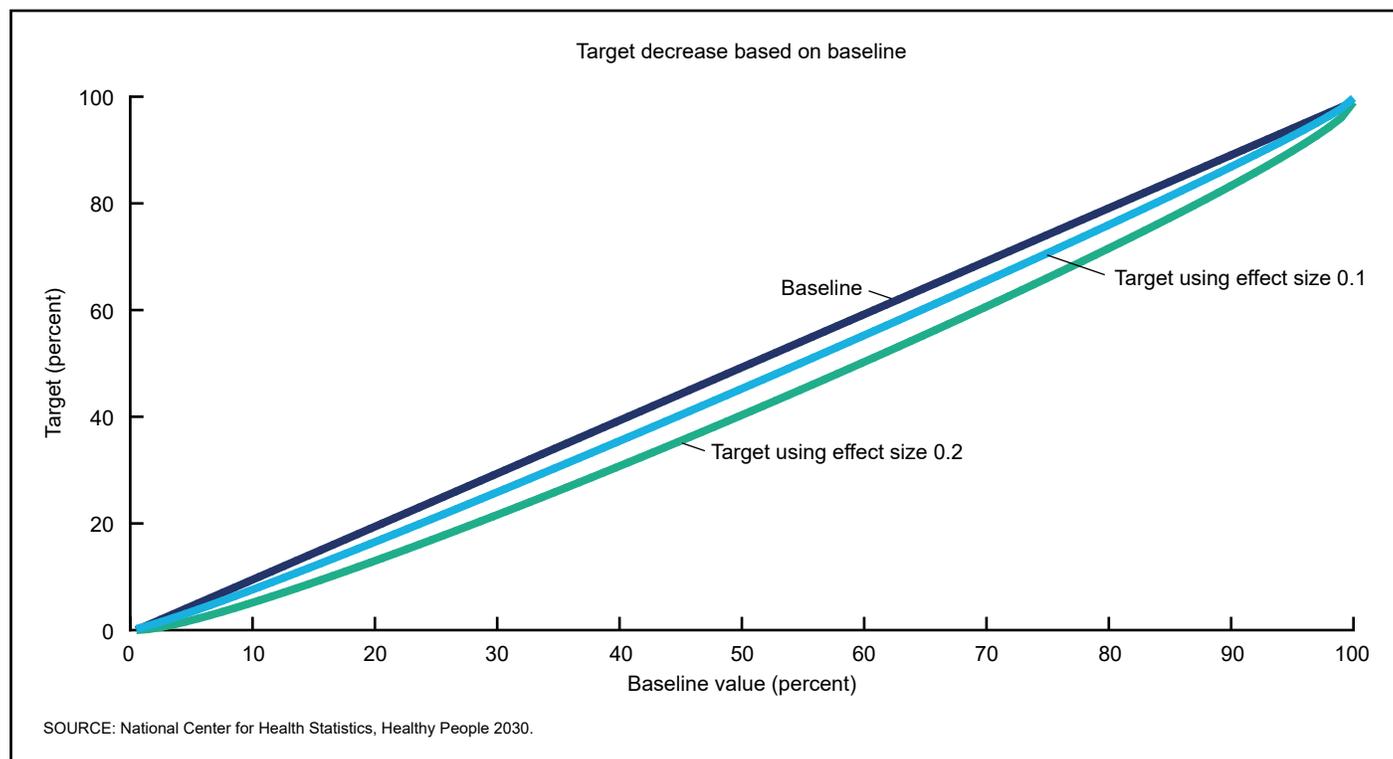


Figure 3b. Target setting for percentages using a directional effect size from baseline when the desired direction is a decrease



HP2030 targets based on trend projection

As described in “Projection,” NCHS focused on calculating targets using projection based on linear trend analysis. Using weighted least squares to fit a trend line based on the historical data allows one to evaluate the fit of the trend line as well as to calculate a predicted value $\hat{y} = \hat{b}_0 + \hat{b}_1 t$ for the future value y at any future time point t . Additionally, because HP2030 objectives have a desired direction (e.g., increase or decrease), one can use the confidence level of one-sided prediction intervals for value y at time t as an indication of how likely a target will be to achieve based on the historical data. For example, a target could be set as the predicted value \hat{y} at time t . Then, because of the symmetry of the prediction error distribution around the predicted value \hat{y} , one would be 50% confident that the future value y will meet or exceed this target. To set a target further from the baseline based on trend projection, when the desired direction is an increase (respectively, decrease), the lower (respectively, upper) endpoint of a one-sided prediction interval can be used to generate other candidate target values. For example, if based on the trend projection, when the desired direction is an increase, the one-sided 33% prediction interval is $(y^*, +\infty)$, then one would be 33% confident that the future value y will meet or exceed the prediction interval boundary y^* , that is, the value y^* could be used as a target that is further from the baseline than \hat{y} at time t based on the historical data points.

Assumptions in weighted least squares trend projection

- In weighted least squares, a data point with a smaller SE is known with higher precision and thus will have a larger influence on the least squares fit than a data point with a larger SE.
- For predicted values, since the weight is unknown, it is imputed using the average of the weights for the observed values. If SEs are not available, then data points are weighted equally and weighted least squares reduces to ordinary least squares.

The mathematical formulation of the weighted least squares trend line based on historical data and the calculation of a trend projection and prediction intervals for future data is described in the next section.

Mathematical details of weighted least squares trend projection

Let y_i denote the value of the indicator at time point i , and let σ_i be the SE. Let t_i be the data year for time point i , with t_i taken as the mid-year for time points that consist of year ranges (e.g., $t_i = 2010.5$ for $i = 2009-2012$). The linear regression model is given by

$$y_i = b_0 + b_1 t_i + \varepsilon_i \quad [1]$$

The coefficients b_0 and b_1 are the intercept and the slope of the trend line, respectively, and the error terms ε_i are normally distributed with mean zero and variance σ_i^2 .

Because the variances are generally unequal, the ordinary least-squares estimators of the coefficients b_0 and b_1 could be inefficient and weighted least-squares estimation is preferable. The weighted least-squares fit is equivalent to an ordinary least-squares fit using the following linear regression model instead of the one shown in equation [1] in this section:

$$z_i = b_0 w_i + b_1 x_i + \delta_i \quad [2]$$

Here, both sides of equation [1] have been multiplied by the weights $w_i = 1/\sigma_i$. Thus, $z_i = w_i \times y_i$, $x_i = w_i \times t_i$, and $\delta_i = w_i \times \varepsilon_i$. As a result, the error terms δ_i are now normally distributed with mean zero and common variance $\sigma^2 = 1$. The slope parameter b_1 remains the same but there is no longer a common “intercept” b_0 ; it is replaced by a time-point specific “offset” $b_0 w_i$. In other words, the z_i in equation [2] are regressed onto both sets of covariates w_i and x_i without an intercept.

The least-squares estimators for the coefficients b_0 and b_1 in equation [2] are:

$$\hat{b}_0 = \frac{(\sum x_i^2)(\sum w_i z_i) - (\sum w_i x_i)(\sum x_i z_i)}{(\sum w_i^2)(\sum x_i^2) - (\sum w_i x_i)^2}$$

$$\hat{b}_1 = \frac{(\sum w_i^2)(\sum x_i z_i) - (\sum w_i x_i)(\sum w_i z_i)}{(\sum w_i^2)(\sum x_i^2) - (\sum w_i x_i)^2}$$

The sample variances of these estimators are given by

$$\widehat{Var}(\hat{b}_0) = \frac{(\sum x_i^2)}{(\sum w_i^2)(\sum x_i^2) - (\sum w_i x_i)^2} \hat{\sigma}^2$$

$$\widehat{Var}(\hat{b}_1) = \frac{(\sum w_i^2)}{(\sum w_i^2)(\sum x_i^2) - (\sum w_i x_i)^2} \hat{\sigma}^2$$

The sample covariance between the regression coefficient estimators \hat{b}_0 and \hat{b}_1 is given by

$$\widehat{Cov}(\hat{b}_0, \hat{b}_1) = \frac{-(\sum w_i x_i)}{(\sum w_i^2)(\sum x_i^2) - (\sum w_i x_i)^2} \hat{\sigma}^2$$

Fitted values and prediction. Fitted values \hat{z}_i from the regression in equation [2] are:

$$\hat{z}_i = \hat{b}_0 w_i + \hat{b}_1 x_i$$

Thus, averaging over the time points, with

$$\bar{z} = \frac{1}{n} \sum z_i, \bar{w} = \frac{1}{n} \sum w_i \text{ and } \bar{x} = \frac{1}{n} \sum x_i,$$

$$\bar{z} = \hat{b}_0 \bar{w} + \hat{b}_1 \bar{x} \quad [3]$$

To predict the future value $z_{new} = w_{new} y_{new}$ at a future time point $x_{new} = w_{new} t_{new}$, since the weight w_{new} is unknown, it is imputed using the (historical) average weight $w_{new} = \bar{w}$. Therefore, the prediction equation is given by

$$\hat{z}_{new} = \hat{b}_0 \bar{w} + \hat{b}_1 x_{new} \quad [4]$$

The prediction error variance PSE^2_{new} is calculated under the assumption of independence between the realized future value z_{new} and the predicted value \hat{z}_{new} , since only historical data (not future data) are used to estimate the regression coefficients and future weight in equation [4]. Thus:

$$\begin{aligned} PSE^2_{new} &= \widehat{Var}(z_{new} - \hat{z}_{new}) = \widehat{Var}(z_{new}) + \widehat{Var}(\hat{z}_{new}) \\ &= \hat{\sigma}^2 + \widehat{Var}(\hat{b}_0 \bar{w} + \hat{b}_1 x_{new}) \quad (\text{from equation [4]}) \\ &= \hat{\sigma}^2 + \widehat{Var}(\bar{z} - \hat{b}_1 \bar{x} + \hat{b}_1 x_{new}) \quad (\text{from equation [3]}) \\ &= \hat{\sigma}^2 + \widehat{Var}(\bar{z}) + (x_{new} - \bar{x})^2 \widehat{Var}(\hat{b}_1) + 2(x_{new} - \bar{x}) \widehat{Cov}(\bar{z}, \hat{b}_1) \\ &= \hat{\sigma}^2 \left(1 + \frac{1}{n}\right) + (x_{new}^2 - \bar{x}^2) \widehat{Var}(\hat{b}_1) + 2\bar{w}(x_{new} - \bar{x}) \widehat{Cov}(\hat{b}_0, \hat{b}_1) \end{aligned}$$

One-sided $100 \times \alpha\%$ prediction intervals are obtained from $\hat{z}_{new} - \tau_{\alpha, n-2} \times PSE_{new}$ when the desired direction is an increase, and $\hat{z}_{new} + \tau_{\alpha, n-2} \times PSE_{new}$ when the desired direction is a decrease, where $\tau_{\alpha, n-2}$ is the $100 \times \alpha$ percentile of the Student- t distribution with $n-2$ degrees of freedom. Intervals are transformed to the original scale by dividing by \bar{w} .

For setting a target that is further from the baseline than \hat{y}_{new} , which, according to the trend projection, one is 50% confident to meet or exceed, the lower (respectively, upper) endpoint of a one-sided $100 \times \alpha\%$ prediction interval with $\alpha < 0.50$ can be used for objectives where the desired direction is an increase (respectively, decrease). For example, when the desired direction is an increase, one would be 33% confident that the future value y will meet or exceed a target value of $\hat{y}_{new} - \tau_{0.33, n-2} \times PSE_{new} / \bar{w}$ at time t .

Considerations of target setting using NCHS trend projection

1. Weighted least squares fits a linear trend line, which is only a good fit for historical trends that are approximately linear. If the historical data are not linear (e.g., quadratic), the time series could be truncated as long as the most recent data point is included and there is a minimum of three data points (12). However, changing the time period can have unforeseen consequences.
2. If the trend is not moving in the desired direction, the projection(s) would not be an improvement from the baseline and, therefore, cannot be used to set a target.

3. If the trend is relatively flat, the projection(s) might not be an improvement from the baseline or might not be statistically different from the baseline.
4. If the projection has a negative value or is over 100% for percentages, then it would not be realistic.
5. The trend projection does not take into consideration subject matter knowledge and it may not be realistic to expect the trend to continue in future years.

Conclusion

This Statistical Note documents the statistical methods underlying the analytical tools that were developed by NCHS for use by the topic area workgroups in setting the HP2030 targets based on percent or percentage point improvement and trend projection. Building on the target-setting work in previous iterations of Healthy People, HP2030 aims for greater transparency and a more data-driven approach for target selection with several new guidelines and tools.

For the first time, a target-setting method selection flowchart was developed for HP2030 to assist topic area workgroups in selecting, in a systematic way, among appropriate TSMs and to help ensure transparency. The topic area workgroups used this information to make the final target selection based on subject matter expertise. TSMs for HP2030 include:

- percent or percentage point improvement;
- projection (e.g., trend projection);
- minimal statistical significance;
- consistency with national programs, regulations, policies, or laws; and
- maintain baseline value.

HP2030 is the first decade in the Healthy People initiative that systematic, decision-based analytical tools were created for setting Healthy People targets. Specifically, NCHS developed new analytical tools for HP2030 target setting based on percent or percentage point improvement and trend projection.

These methods, tools, and documentations have been instrumental in setting transparent, data-driven targets for HP2030 on a national level and may be useful for other public health initiatives that also set quantifiable targets.

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Appendix

HP2030 targets based on minimal statistical significance

When the baseline standard error (SE) is available, and imputing the unknown SE at the target year(s) using the SE at baseline year(s), a minimal statistical significance-based target is calculated using the following formula, which assumes a two-sided test and a 0.05 level of significance:

$$\text{Baseline} \pm 1.96\sqrt{2} \times SE$$

In HP2020, both the extent of the movement (10% or more of the targeted change for objectives moving toward their targets, or 10% or more relative to baseline for objectives moving away from their targets) and its statistical significance (when measures of variability were available) were used to determine progress status (e.g., “improving,” “little or no detectable change,” or “getting worse”) (8).

Minimal statistical significance, while useful as a benchmark for measuring progress statistically, can be challenging for tracking progress over the decade because, assuming the HP2020 categories for tracking progress are used in HP2030, an objective could demonstrate “little or no detectable change” throughout the time period leading to it meeting or exceeding its target, even if it was moving toward the target throughout.

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