

## Measuring Progress Toward Target Attainment and the Elimination of Health Disparities in Healthy People 2020

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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 for improving the health of all Americans. As in the previous three decades, Healthy People 2020 (HP2020) has established overarching goals and objectives, and is monitoring progress toward the attainment of its targets as well as the elimination of health disparities among population groups. This Statistical Note discusses the HP2020 measurement practices, contrasting them with those that were in place in Healthy People 2010 (HP2010) and highlighting their strengths and limitations.

**Objective**—This Statistical Note documents the HP2020 methodology for measuring progress toward target attainment and the elimination of health disparities, with a particular focus on methodological considerations for the interpretation of findings.

**Progress toward target attainment**—For HP2020, the “percent of targeted change achieved” still measures movement of objectives that are moving from their baselines toward their targets. However, for objectives moving away from their baselines and targets, the

“absolute value of the percent change from baseline” is used to measure movement. In addition, unlike in HP2010, both the extent of the movement and its statistical significance (when measures of variability are available) are used to determine progress status in HP2020 (e.g., “improving,” “little or no detectable change,” or “getting worse”).

**Comparisons to the best group rate**—As in HP2010, all groups composing a population domain (e.g., race and ethnicity, education, or income) are compared to the group with the “best” (i.e., most favorable or least adverse) rate. However, HP2020 uses the ratio instead of the percent difference between the rates. In addition, HP2020 objectives that are expressed in terms of favorable outcomes to be increased no longer need to be re-expressed using the complementary adverse outcomes for comparisons to the best group rate.

**Measures of overall health disparity**—In addition to detailed comparisons to the best group rate, HP2020 provides measures that quantify the degree of disparity overall across all groups composing a population domain. Unlike in HP2010, where a single relative measure, the summary index, was used, HP2020 uses three measures that include

both absolute and relative measures of overall disparity: a) the simple difference between the highest and lowest rates, irrespective of intermediate rates; b) the ratio between the highest and lowest rates, irrespective of intermediate rates; c) and a summary rate ratio between the best group rate and the average rate for all other groups in a population domain. For objectives expressed in terms of adverse outcomes, the HP2010 “index of disparity” is obtained by subtracting 1 from the HP2020 summary rate ratio and multiplying by 100.

**Conclusion**—The multipronged approach to measurement in HP2020 addresses some of the complex methodological issues and limitations identified in the past decade as well as elsewhere in the literature.

**Keywords:** Healthy People objectives • measurement • population subgroups • health equity



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## Introduction

This Statistical Note describes the Healthy People 2020 (HP2020) methodology for measuring progress toward target attainment and the elimination of health disparities, with a particular focus on methodological issues. The HP2020 measurement practices are contrasted with those in place for the Healthy People 2010 (HP2010) decade; see Statistical Note No. 25, *Measuring Progress in Healthy People 2010* (1), as well as the Healthy People 2010 midcourse and final reviews (2,3).

Healthy People is an initiative of the U.S. Department of Health and Human Services (HHS) that provides science-based, 10-year national objectives for improving the health of all Americans. For three decades, Healthy People has established benchmarks and monitored progress over time to “encourage collaborations across communities and sectors, empower individuals toward making informed health decisions, and measure impact of prevention activities”; see <http://www.healthypeople.gov/2020/About-Healthy-People>. Healthy People 2020, the fourth decade of the initiative, was launched in December 2010.

## Overarching goals

The four overarching goals established for HP2020 are to:

- Attain high-quality, longer lives free of preventable disease, disability, injury, and premature death.
- Achieve health equity, eliminate disparities, and improve the health of all groups.
- Create social and physical environments that promote good health for all.
- Promote quality of life, healthy development, and healthy behaviors across all life stages.

## Measurable objectives and targets

There are more than 1,200 objectives in HP2020 spanning 42 topic areas, including just over 1,000 that were measurable as of June 2015. Each measurable objective has a nationally representative data source, baseline value, and target for specific improvements to be achieved by the year 2020. A few objectives have nationally representative data, yet they are tracked only for informational purposes, so they do not have 2020 targets. Just over 200 developmental objectives do not have baseline data, yet they have a potential data source and are included in HP2020 to highlight their public health importance and are expected to become measurable over the course of the decade.

Prior to their potential inclusion in HP2020, objectives are drafted by subject matter experts from various federal agencies. The proposed objectives are made available for public comment and are reviewed by the Healthy People Federal Interagency Workgroup. All objectives are approved by HHS before being added to the HP2020 initiative.

Whenever possible, targets for the HP2020 objectives are set using science-based methods, such as:

- Modeling
- Projecting trends
- Knowledge of scientific findings and current interventions

In the absence of adequate data, knowledge, or expertise, HP2020 targets generally are set using a projected 10% improvement relative to their baseline values. On a case-by-case basis, other target-setting methods are used as appropriate (e.g., minimal statistical significance; total elimination; maintaining baseline level; maintaining consistency with national programs, regulations, policies, or laws; or retention of HP2010 targets).

Complete information about HP2020, including the initiative's history, its overarching goals, and objectives, is available from <http://www.healthypeople.gov>.

## Population subgroups

Measurable HP2020 objectives that are population-based include data by demographic and socioeconomic categories, where available. For example, [Table 1](#) shows HP2020 demographic and socioeconomic categories used to tabulate national data from the National Health Interview Survey (NHIS), which is the data source for over 100 measurable population-based HP2020 objectives.

HP2020 strives for consistency in tracking population groups; however, population categories may vary by data source or by objective, due to survey design, data collection constraints, or other considerations. Therefore, HP2020 population categories used to tabulate national data from data

**Table 1. Main population categories for HP2020 objectives from the National Health Interview Survey**

Population categories	Population categories
Total	Family income (percent of poverty threshold)
Sex	Less than 100%
Female	100%–199%
Male	200%–399%
Race and ethnicity	400%–599%
American Indian or Alaska Native only	600% and above
Asian only	Family type
Native Hawaiian or Other Pacific Islander only	Single
Black or African American only	Single parent with children
White only	Married couple or partners
Two or more races	Two parent family with children
Hispanic or Latino	Other
Not Hispanic or Latino	Country of birth
Black or African American only, not Hispanic or Latino	United States
White only, not Hispanic or Latino	Outside United States
Age group (years)	Disability status
Under 18	Persons with activity limitations
0–4	Persons without activity limitations
5–11	Geographic location
12–17	Metropolitan
18–44	Nonmetropolitan
18–24	Health insurance status (persons under age 65)
25–44	Insured
45–64	Private
45–54	Public
55–64	Uninsured
65 and over	Marital status (persons aged 18 and over)
65–74	Married
75–84	Cohabiting partner
85 and over	Divorced or separated
Educational attainment (persons aged 25 and over)	Widowed
Less than high school	Never married
High school	
Some college	
Associate's degree	
Four-year college degree	
Advanced degree	

NOTE: Additional population categories may be added as needed.  
SOURCE: CDC/NCHS, HP2020 database.

sources other than NHIS may differ from those listed in [Table 1](#).

HP2020 population categories differ from those used in HP2010:

- *Education and income.* Both education and income are included in HP2020 data tables when they are available. In HP2010 data tables, only one of these variables typically was reported, even if the data source provided both. In addition, both education and income have a more granular disaggregation in HP2020 than that used in HP2010.
- *New category options in HP2020.* A number of options have been added to data tables in HP2020. Whereas some of these options were included in HP2010 when data were available (e.g., age, disability status, health insurance status, geographic location, and sexual orientation), other

options are new for HP2020 (e.g., country of birth, family type, and marital status).

Several population categories may be limited to persons of a specific age group (e.g., educational attainment, marital status, veteran status, and health insurance status). The age groups that apply to these categories are specific to each objective and may vary by data source. Caution must be used when comparing data for population categories that use different age limits or when comparing to the total population.

Data may be either unavailable or not collected for population categories not shown in the HP2020 data tables. However, if the data for a population subgroup have been collected and analyzed but do not meet the criteria for statistical reliability, data quality, or confidentiality, the data are suppressed and marked accordingly in the data tables.

Detailed information about data suppression as well as additional considerations related to the demographic and

socioeconomic categories used in HP2020 are forthcoming from: [http://www.cdc.gov/nchs/healthy\\_people/hp2020/hp2020\\_data\\_issues.htm](http://www.cdc.gov/nchs/healthy_people/hp2020/hp2020_data_issues.htm).

## Multipronged Measure of Progress Toward HP2020 Targets

For HP2010 objectives that had at least two data points, the “percent of targeted change achieved” was used to quantify progress toward target attainment, unless the target had been met or exceeded at baseline. The formula for the “percent of targeted change achieved” was as follows:

$$\text{Percent of targeted change achieved} = \frac{\text{Most recent value} - \text{Baseline value}}{\text{HP2010 target} - \text{Baseline value}} \times 100.$$

The “percent of targeted change achieved” expressed the difference between the baseline and the most recent value as a percent of the targeted change between the baseline and the HP2010 target. The “percent of targeted change achieved” was used to compare how much of the targeted change was achieved for an objective relative to other HP2010 objectives. For more information about the measurement of progress toward target attainment in HP2010, see [Appendix I](#).

As learned in the *Healthy People 2010 Final Review* (3), there are various limitations to using the “percent of targeted change achieved” as the sole measure of progress toward target attainment, some of which are listed here:

- The “percent of targeted change achieved” is calculated using only the target, baseline, and most recent data points. Fluctuations during the intervening years are not considered.
- The number of years between the baseline and most recent data points might vary between objectives (e.g., data systems may have different data collection frequencies).
- Two objectives may be identical in their “percent of targeted change achieved,” even though they differ in the amount of both the targeted and realized change from baseline.
- Objectives moving away from their targets and those whose targets are exceeded at the baseline yield a negative “percent of targeted change achieved” value, and these negative values are difficult to interpret.

For HP2020, the “percent of targeted change achieved” still quantifies progress for objectives that are moving toward their targets. However, for objectives moving away from their baselines and targets, the “absolute value of the percent change from baseline” is used to measure movement. An objective that moves away from its baseline and target would

need to make up the deficit from baseline in addition to the desired targeted change once the baseline value is regained.

In HP2010, the amount and statistical significance of the “percent of targeted change achieved” were not considered in determining an objective’s progress status. For HP2020, both the extent of the movement and its statistical significance (when measures of variability are available) are used to determine an objective’s progress status. Thus, in addition to HP2020 objectives where the values at baseline and most recent data points are equal, those objectives with available standard errors for which movement was not statistically significant, and those with no available standard errors for which movement was less than 10%, are all qualified as having demonstrated “little or no detectable” change.

## Classification of objective progress status in HP2020

HP2020 objectives are classified according to the status of their progress toward their targets or away from their baselines, as shown in [Table 2](#).

## Determination of objective progress status in HP2020

### Objectives that met or exceeded their targets

- When the desired direction is increase, an objective *has met or exceeded* its target at the most recent data point if  $\text{most recent value} \geq \text{HP2020 target}$ .
- When the desired direction is decrease, an objective *has met or exceeded* its target at the most recent data point if  $\text{most recent value} \leq \text{HP2020 target}$ .

HP2020 objectives that met or exceeded their targets at the most recent data point are designated by a TARGET MET progress status indicator. Even though statistical significance, when measures of variability are available, is not factored into the determination of the TARGET MET status, the movement is still evaluated for statistical significance; see [Table 3](#) for an example.

### Objectives moving toward their targets

#### Direction

- When the desired direction is increase, an objective is *moving toward* its target at the most recent data point if  $\text{baseline value} < \text{most recent value} < \text{HP2020 target}$ .
- When the desired direction is decrease, an objective is *moving toward* its target at the most recent data point if  $\text{baseline value} > \text{most recent value} > \text{HP2020 target}$ .

## Extent of movement toward target

For HP2020 objectives that had not already met or exceeded their targets at baseline, the “percent of targeted change achieved” measures the extent of movement toward the target. It is given by:

$$\text{Percent of targeted change achieved} = \frac{\text{Most recent value} - \text{Baseline value}}{\text{HP2020 target} - \text{Baseline value}} \times 100.$$

## Statistical significance for objectives moving toward, or meeting or exceeding their targets

In HP2010, statistical significance of the “percent of targeted change achieved” was not evaluated when measures of variability were available. Instead, the statistical significance of the simple difference “most recent value – baseline value” was assessed to determine whether the change from baseline to the most recent value was statistically significant, irrespective of the target.

In HP2020, statistical significance of the “percent of targeted change achieved” is evaluated using Taylor linearization when measures of variability are available. A one-sided 0.05-level test is used.

When measures of variability are available, the IMPROVING status indicator is designated for a statistically significant “percent of targeted change achieved,” regardless of the amount of the change, whereas the LITTLE OR NO DETECTABLE CHANGE status indicator is designated for a “percent of targeted change achieved” that is not statistically significant, regardless of the amount of the change.

Several steps are required to evaluate statistical significance:

**Step 1.** The “percent of targeted change achieved” (or “progress quotient,” PQ) is based on the ratio of the simple difference  $SD_t = R_t - R_b$  between the rate  $R_t$  at time  $t$  and the rate  $R_b$  at baseline and the targeted change  $SD_T = R_T - R_b$  between the target rate  $R_T$  and the rate  $R_b$  at baseline:

$$PQ = \frac{SD_t}{SD_T} \times 100.$$

Because the “percent of targeted change achieved” is used only for HP2020 objectives that are moving toward, or meeting or exceeding their targets,  $PQ \geq 0$ .

**Step 2.** The relative standard error (RSE) of the above ratio is computed based on the RSE of the numerator and the denominator. The RSE for the numerator,  $SD_t$ , is calculated as:

$$RSE_{SD_t} = \frac{\sqrt{SE_t^2 + SE_b^2}}{|R_t - R_b|},$$

where  $SE_t$  is the standard error at time  $t$  and  $SE_b$  is the standard error at baseline.

**Step 3.** The RSE for the denominator,  $SD_T$ , is calculated as:

$$RSE_{SD_T} = \frac{SE_b}{|R_T - R_b|},$$

because the target  $R_T$  does not contribute to the variability of the targeted change; it is constant.

**Step 4.** An approximate RSE for the PQ is computed using a first-order Taylor series linearization of the variance of the ratio of two random variables, with numerator and denominator RSEs, above:

$$RSE_{PQ} = \sqrt{RSE_{SD_t}^2 + RSE_{SD_T}^2}.$$

**Table 2. Classification of HP2020 objectives, by progress status**

Objective status	Short explanation
TARGET MET	Target met or exceeded
IMPROVING	Movement is <i>toward</i> the target and is either: – Statistically significant when measures of variability are available. – OR – Ten percent or more of the targeted change when measures of variability are unavailable.
LITTLE OR NO DETECTABLE CHANGE	Objective demonstrates little or no detectable change, because either: – Movement toward the target is not statistically significant when measures of variability are available. – OR – Movement is toward the target but the objective has achieved less than 10% of the targeted change when measures of variability are unavailable. – OR – Movement away from the baseline and target is not statistically significant when measures of variability are available. – OR – Movement is away from the baseline and target but the objective has moved less than 10% relative to its baseline when measures of variability are unavailable. – OR – No change between baseline and most recent data point.
GETTING WORSE	Movement is <i>away from</i> the baseline and target and is either: – Statistically significant when measures of variability are available. – OR – Ten percent or more relative to the baseline when measures of variability are unavailable.
BASELINE ONLY	Baseline data only; progress cannot be assessed.
INFORMATIONAL	Objective is informational (does not have a target).
DEVELOPMENTAL	Objective is developmental (does not have baseline data).

SOURCE: CDC/NCHS, HP2020 database.

This approximation assumes the simple difference  $SD_t$  is independent of the targeted change  $SD_T$ .

**Step 5.** An approximate standard error  $SE_{PQ}$  for the PQ is given by  $SE_{PQ} = RSE_{PQ} \times PQ$ .

**Step 6.** Statistical significance of the PQ is assessed using the statistic  $z = PQ/SE_{PQ}$ . Because  $PQ \geq 0$ , statistical significance is based on a one-sided test, which, assuming normality, compares the value of  $z$  to 1.64485 for a 0.05-level test.

When measures of variability are unavailable, the IMPROVING status indicator is designated for objectives that are moving toward their targets and for which the “percent of targeted change achieved” is 10% or more. Objectives for which the “percent of targeted change achieved” is 100% or more have met or exceeded their targets and are designated as TARGET MET.

## Objectives moving away from their baselines and targets

### Direction

- When the desired direction is increase, an objective is *moving away* from its baseline and target at the most recent data point if *most recent value* < *HP2020 target* and *most recent value* < *baseline value*.
- When the desired direction is decrease, an objective is *moving away* from its baseline and target at the most recent data point if *most recent value* > *HP2020 target* and *most recent value* > *baseline value*.

### Extent of movement away from baseline

Movement away from baseline is quantified using:

$$\text{Absolute value of percent change from baseline} = \frac{\left| \begin{array}{cc} \text{Most recent} & \text{Baseline} \\ \text{value} & \text{value} \end{array} \right|}{\text{Baseline value}} \times 100.$$

A percent change from baseline of 10% or more in absolute value means that the objective is at least 10% in deficit relative to its baseline. Such an objective would need to make up the deficit from baseline in addition to the desired targeted change once the baseline value is regained.

### Statistical significance for objectives moving away from their baselines and targets

When measures of variability are available, the GETTING WORSE status indicator is designated for a statistically significant “absolute value of percent change from baseline,” regardless of the value, whereas the LITTLE OR NO DETECTABLE CHANGE status indicator is designated for a percent change from baseline that is not statistically

significant, regardless of the value; for an example, see [Table 3](#).

When measures of variability are available, statistical significance of the “absolute value of the percent change from baseline” is evaluated using Taylor linearization. A one-sided 0.05-level test is used. Several steps are required to evaluate statistical significance:

**Step 1.** The absolute value of the percent change from baseline (PC) is based on the ratio of the simple difference  $SD_t = R_t - R_b$  between the rate  $R_t$  at time  $t$  and the rate  $R_b$  at baseline and the rate  $R_b$ :

$$PC = \begin{cases} \frac{-SD_t}{R_b} \times 100, & \text{when desired direction is increase,} \\ & \text{but } R_t < R_T \text{ and } R_t < R_b \\ \frac{+SD_t}{R_b} \times 100, & \text{when desired direction is decrease,} \\ & \text{but } R_t > R_T \text{ and } R_t > R_b \end{cases}.$$

By construction,  $PC \geq 0$ .

**Step 2.** The RSE of the PC is computed based on the RSE of the numerator and the denominator in the ratio. The RSE for the numerator,  $SD_t$ , is calculated as:

$$RSE_{SD_t} = \frac{\sqrt{SE_t^2 + SE_b^2}}{|R_t - R_b|}$$

where  $SE_t$  is the standard error at time  $t$  and  $SE_b$  is the standard error at baseline.

**Step 3.** The RSE for the denominator,  $R_b$ , is calculated as:

$$RSE_{R_b} = \frac{SE_b}{|R_b|}.$$

**Step 4.** An approximate RSE for the PC is computed using first-order Taylor series linearization, assuming the simple difference  $SD_t$  is independent of the baseline rate  $R_b$ :

$$RSE_{PC} = \sqrt{RSE_{SD_t}^2 + RSE_{R_b}^2}.$$

**Step 5.** An approximate standard error  $SE_{PC}$  for the PC is given by  $SE_{PC} = RSE_{PC} \times PC$ .

**Step 6.** Statistical significance of the PC is assessed using the statistic  $z = PC/SE_{PC}$ . Because the “absolute value of the percent change from baseline” is used only for objectives that are moving away from their baselines and targets, significance is based on assuming normality and comparing  $z$  to 1.64485 for a one-sided 0.05-level test.

When measures of variability are unavailable, the GETTING WORSE status indicator is designated for HP2020 objectives that are moving away from their baselines and

targets and for which the “absolute value of the percent change from baseline” is 10% or more.

## Objectives for which progress toward target attainment cannot be assessed

Progress toward target attainment cannot be assessed when only baseline data are available, the target was met at baseline, or the objective’s desired direction is to “maintain the baseline.” In addition, progress toward target attainment is not assessed when an objective is informational and does not have a target (e.g., PH-7.3, Increase the proportion of population-based HP2020 objectives for which national data are available by socioeconomic status).

## Illustration of HP2020 classification of objective status

HP2020 contains 42 topic areas with over 1,200 objectives. A smaller set of HP2020 objectives, called the Leading Health Indicators, was selected at the launch of HP2020 to communicate high-priority health issues; see <http://www.healthypeople.gov/2020/Leading-Health-Indicators>. Table 3 illustrates the HP2020 classification of objective status using five of these HP2020 Leading Health Indicators.

**Remark.** The “percent of targeted change achieved” for HP2020 objectives that are moving toward their targets and the “absolute value of percent change from baseline” for those moving away from their baselines and targets are calculated from the “display” values of the estimates at the baseline and most recent time points—in particular, unless otherwise specified, rates and percentages are rounded to one decimal place before being displayed in HP2020 data tables, whereas standard errors are displayed using three decimal places when measures of variability are available. This is consistent with HP2010, where “display” values also were used in progress calculations (3).

## Considerations

In addition to the aforementioned limitations to using the “percent of targeted change achieved,” HP2020 progress measures are subject to the following considerations.

- As in HP2010, the “percent of targeted change achieved” is calculated using only the target, baseline, and most recent data points. Similarly, the “absolute value of the percent change from baseline” is calculated using only the baseline and most recent data points. As in HP2010, to facilitate comparisons between objectives, any underlying trends and fluctuations that occur during

**Table 3. Objective status classification for selected HP2020 Leading Health Indicators**

Objective status	Objective description	Baseline estimate (year)	Most recent estimate (year)	Target	Movement toward target <sup>1</sup>	Movement away from baseline and target <sup>2</sup>	Movement statistically significant <sup>3</sup>
TARGET MET	TU-11.1 Children exposed to secondhand smoke (percent among nonsmokers aged 3–11)	52.2 (2005–2008)	41.3 (2009–2012)	47.0	209.6	...	Yes
IMPROVING	C-16 Adults receiving colorectal cancer screening based on most recent guidelines (age-adjusted percent among adults aged 50–75)	52.1 (2008)	58.2 (2013)	70.5	33.2	...	Yes
LITTLE OR NO DETECTABLE CHANGE	AHS-1.1 Persons with medical insurance (percent among persons under age 65)	83.2 (2008)	83.3 (2013)	100	0.6	...	No
LITTLE OR NO DETECTABLE CHANGE	D-5.1 Persons with diagnosed diabetes whose A1c value is greater than 9 percent (age-adjusted percent among adults aged 18 and over)	17.9 (2005–2008)	21.0 (2009–2012)	16.1	...	17.3	No
GETTING WORSE	MHMD-1 Suicide (age-adjusted rate per 100,000 population)	11.3 (2007)	12.6 (2013)	10.2	...	11.5	Yes

... Category not applicable.

<sup>1</sup>Quantified using the “percent of targeted change achieved.”

<sup>2</sup>Quantified using the “absolute value of the percent change from baseline.”

<sup>3</sup>When measures of variability are available, statistical significance is based on a one-sided 0.05-level test for either the “percent of targeted change achieved” or the “absolute value of the percent change from baseline.”

### DATA SOURCES:

AHS-1.1	CDC/NCHS, National Health Interview Survey.
C-16	CDC/NCHS, National Health Interview Survey.
D-5.1	CDC/NCHS, National Health and Nutrition Examination Survey.
MHMD-1	CDC/NCHS, National Vital Statistics System-Mortality.
TU-11.1	CDC/NCHS, National Health and Nutrition Examination Survey.

the intervening years are not considered—because the number and spacing of data points between the baseline and most recent data points vary between objectives.

- As in HP2010, two objectives that are moving toward their targets may be identical in the “percent of targeted change achieved” even though they differ in the amount of the absolute change from baseline. Similarly, two objectives that are moving away from their baselines may be identical in the “absolute value of the percent change from baseline” even though they differ in the amount of the absolute change from baseline.
- The two measures of progress in HP2020—“percent of targeted change achieved” for objectives moving toward their targets and “absolute value of percent change from baseline” for objectives moving away from their baselines—are not comparable because they use different measurement standards—targeted change versus baseline value. For example:
  - Objective MHMD-1 is getting worse, having increased by 1.3 percentage points from its baseline—a percent change from baseline of 11.5% in magnitude (Table 3).
  - C-16 is improving, having increased by 6.1 percentage points from its baseline—realizing 33.2% of the targeted 18.4 percentage point change from baseline.
  - If, instead, C-16 had achieved just 11.5% of its targeted change from baseline, then it would have increased by only 2.1 percentage points. Thus, even though the “percent of targeted change achieved” for C-16 would be equal to the “absolute value of the percent change from baseline” for MHMD-1, 11.5%, the amount of the absolute change from baseline for C-16 would be over 1.5 times that for MHMD-1 (2.1 versus 1.3 percentage points).

## Measures of Health Disparities in HP2020

This section describes the measurement of health disparities and changes in disparities over time in HP2020. Detailed information on evaluating the statistical significance of the HP2020 health disparities measures when measures of variability are available is provided. The HP2020 disparities measures are also related to the corresponding HP2010 measures, which are described in Appendix II.

### Motivation for adopting revised health disparities measures in HP2020

As is recognized in the *Healthy People 2010 Final Review* and established elsewhere in the literature, there are

important technical and conceptual considerations in the measurement and tracking of health disparities (3–7). Some of the considerations that were particularly relevant to the HP2010 health disparities measures and that have provided the impetus for developing the HP2020 health disparities measures are outlined below.

- The percent difference (PD) relative to the best group rate was measured only for adverse outcomes in HP2010; see Appendix II. Those dichotomous objectives that had been expressed in terms of favorable outcomes were re-expressed using the complementary adverse outcome for the purpose of computing the PD relative to the best group rate.
- Because the best group rate is theoretically achievable by other groups associated with a given population characteristic, the PD relative to the best group rate can highlight an opportunity for improvement (7). However:
  - In HP2010, concerns about the stability of the best group rate, and, therefore, the reliability of disparities findings based on the percent differences from the best group rate, led to imposing a standard of reliability on its selection. When estimates of variability were available, the RSE of the rate identified as the best group rate was required to be less than 10%; if it was not, then the next best rate with RSE < 10% was used as the reference for evaluating disparities. As a result, the percent differences that were presented in *Healthy People 2010 Final Review* tended to be smaller than if this reliability standard had not been applied (3).
  - The PD expresses disparity for the comparison group as a percent difference relative to the best group rate. However, to highlight opportunities for improvement, lack of parity with the best group rate is more readily expressed using the percent difference relative to the comparison group itself. For example, in 2008, approximately 28% of the American Indian or Alaska Native population under age 65 did not have health insurance, compared with 12% of the non-Hispanic white population under age 65 (best group rate; HP2010 objective 1-1). Thus, relative to the best group rate, PD = 133%. However, to express the amount by which the uninsurance rate among the American Indian or Alaska Native population under age 65 would need to be reduced in 2008 to achieve parity with the best group rate, the percent difference relative to the comparison group would be useful: 57%.
- In part for simplicity, but also in part due to the 10% reliability standard imposed on the best group rate, the standard error  $SE_{PD}$  for the PD was not used in HP2010 for assessing the statistical significance of the percent difference, PD. Instead, the simple difference, SD, was tested for significance, and the PD was flagged whenever the SD was statistically significant at the 0.05 level (1).

- Measures of health disparities reflect implicit value judgments and trade-offs, particularly in the choice of the reference for evaluating disparities, whether to measure disparities using the absolute or the relative scale, and whether to weight population groups equally or according to their size. These as well as other conceptual issues in the measurement of health disparities are discussed elsewhere; see (4,6,7).

Because findings of health disparities in HP2010, especially when using the relative scale, could be affected by whether an objective was expressed in terms of the favorable health outcome or its adverse complementary outcome (3,4), HP2020 set out to construct measures of health disparities that explicitly accounted for an objective's directionality. In addition, to account for some of the conceptual issues around absolute versus relative disparities, HP2020 uses a suite of measures that includes both absolute and relative measures of overall disparity. The HP2020 approach to measuring health disparities using a suite of measures is consistent with current practices; for example, it is consistent with the National Cancer Institute's health disparities calculator (8,9).

## Comparisons to the best group rate in HP2020

### HP2020 rate ratio ( $RR_g$ )

#### Definition

Let  $R_B$  denote the best group rate and  $R_g$  denote any other group's rate. The rate ratio  $R_g/R_B$  (a common relative measure in the epidemiologic literature) for comparing  $R_g$  to  $R_B$  can be modified to yield the following pairwise measure, which will be referred to as the HP2020 rate ratio and denoted as  $RR_g$ :

$$RR_g = \max \left\{ \frac{R_B}{R_g}, \frac{R_g}{R_B} \right\}.$$

Note that regardless of whether the objective is expressed as a favorable outcome to be increased—in which case  $RR_g = R_B/R_g$ —or as an adverse outcome to be decreased—for which  $RR_g = R_g/R_B$ —the HP2020 rate ratio  $RR_g$  is constructed such that  $RR_g \geq 1$ .

#### Statistical significance

When measures of variability are available, statistical significance is based on assuming normality and comparing the test statistic to 1.64485 for a one-sided 0.05-level test. Because the distribution of the rate ratio is typically skewed to the right, the natural logarithm transformation is applied first, as described below.

When  $R_B$  and  $R_g$  have standard errors  $SE_B$  and  $SE_g$ , respectively, and are assumed independent, an approximate

standard error of the natural logarithm of the  $RR_g$  is evaluated using the formula:

$$SE_{\ln(RR_g)} = \sqrt{\left(\frac{SE_B}{R_B}\right)^2 + \left(\frac{SE_g}{R_g}\right)^2}.$$

#### One-sided significance test for $RR_g$

- Testing  $RR_g = 1$  versus  $RR_g > 1$  is equivalent to testing  $\ln(RR_g) = 0$  versus  $\ln(RR_g) > 0$ .
- The statistic for testing  $\ln(RR_g) = 0$  versus  $\ln(RR_g) > 0$  is given by:

$$z = \ln(RR_g)/SE_{\ln(RR_g)}.$$

- The rate ratio  $RR_g$  is statistically significant at the 0.05 level if  $z > 1.64485$ .

#### One-sided confidence interval for $RR_g$

- The upper limit (UL) is computed via the inverse transformation as follows:

$$UL = \exp\{\ln(RR_g) + 1.64485 \times SE_{\ln(RR_g)}\}.$$

- A 95% confidence interval for  $RR_g$  has lower limit = 1.000 and upper limit = UL.

#### Relation to percent difference from best group rate

The percent difference was used for comparisons to the best group rate in HP2010; see [Appendix II](#).

#### Objectives expressed in terms of adverse outcomes

For objectives expressed in terms of adverse outcomes to be reduced, the HP2020 rate ratio  $RR_g$  is given by  $RR_g = R_g/R_B$ . The HP2010 percent difference  $PD_g$  relative to the best group rate is seen as:

$$PD_g = (RR_g - 1) \times 100.$$

Thus, the HP2010 percent difference  $PD_g$  is obtained by subtracting 1 from the HP2020 rate ratio  $RR_g$  and multiplying by 100 when objectives are expressed in terms of adverse outcomes.

#### Objectives expressed in terms of favorable outcomes

For objectives expressed in terms of favorable outcomes to be increased, the rate ratio  $RR_g$  is given by  $RR_g = R_B/R_g$ . In HP2010, the percent difference  $PD_g$  was calculated using the complementary adverse outcome, with rates  $\check{R}_B$  and  $\check{R}_g$ . For example, the AHS-1.1 objective shown in [Table 4](#) has the lowest *uninsurance* rate  $\check{R}_B = 5.2\%$  ( $100 - 94.8$ ), realized

by persons aged 25 to under 65 with an advanced degree, whereas the *uninsurance* rate for those with less than a high school education, say, is  $\check{R}_g = 43.3\%$  ( $100 - 56.7$ ). The HP2010 percent difference  $PD_g$  is given by:

$$PD_g = \frac{\check{R}_g - \check{R}_B}{\check{R}_B} \times 100.$$

Because the difference  $\check{R}_g - \check{R}_B$  between the adverse rates is the same as the difference  $R_B - R_g$  between the favorable rates, it follows that the HP2010 percent difference  $PD_g$  can be expressed as:

$$PD_g = \frac{R_B}{\check{R}_B} \times \left(1 - \frac{1}{RR_g}\right) \times 100.$$

Thus, the mathematical relationship between the HP2010 percent difference  $PD_g$  and the HP2020 rate ratio  $RR_g$  is nonlinear when objectives are expressed in terms of favorable outcomes to be increased.

## HP2020 measures of overall health disparity

In addition to the detailed comparisons to the best group rate that the HP2020 rate ratio  $RR_g$  facilitates, HP2020 provides measures that quantify the degree of disparity overall across all groups composing a population domain (e.g., race and ethnicity, education, or income). Unlike in HP2010, where a single relative measure, the summary index, was used (see [Appendix II](#)), HP2020 uses three measures that include both absolute and relative measures of overall disparity:

- The maximal rate difference, defined as the simple difference between the highest and lowest rates, irrespective of intermediate rates.
- The maximal rate ratio, defined as the ratio between the highest and lowest rates, irrespective of intermediate rates.
- The summary rate ratio, defined using a ratio between the best group rate and the average rate for all other groups in a population domain—as seen below, for objectives expressed in terms of adverse outcomes, the HP2010 summary index is obtained by subtracting 1 from the HP2020 summary rate ratio and multiplying by 100.

The maximal rate difference is useful for tracking changes over time. Tracking the maximal rate difference over time allows the analyst to determine whether, overall, the absolute difference between the highest and lowest rates is decreasing. While this does not capture whether the population health outcome overall is improving, it does allow the analyst to evaluate overall progress toward eliminating disparities, because as the absolute difference between the highest and lowest rates decreases toward 0, all of the

pairwise absolute differences between population subgroups will tend to 0.

Additionally, the maximal rate ratio is useful for comparing objectives that are measured on different scales.

Even though their simplicity is appealing, the maximal rate difference and maximal rate ratio are not designed to summarize “typical” or average disparities well, because they do not take into account any of the intermediate rates (10). Instead, the HP2020 summary rate ratio, introduced below, extends the HP2010 index of disparity (4,5) and focuses on a ratio between the best group rate and the average for all other groups, resulting in a more conservative measure of overall health disparity.

## Maximal rate difference ( $RD_{max}$ )

### Definition

Let  $R_B$  denote the best group rate and  $R_W$  denote the worst group rate. The maximal rate difference ( $RD_{max}$ ) is an *absolute* measure of health disparities that compares the highest and lowest group rates in the population for a given characteristic.  $RD_{max}$  is calculated as follows:

$$RD_{max} = \max\{R_B - R_W, R_W - R_B\}.$$

Irrespective of whether an objective is expressed in terms of a favorable outcome to be increased—in which case  $RR_{max} = R_B - R_W$ —or an adverse outcome to be decreased—from where  $RR_{max} = R_W - R_B$ —the maximal rate difference  $RD_{max}$  remains nonnegative.

### Statistical significance

When  $R_B$  and  $R_W$  have associated standard errors  $SE_B$  and  $SE_W$ , respectively, the standard error of  $RD_{max}$  is approximated using the following formula, which assumes the two rates are independent:

$$SE_{RD_{max}} = \sqrt{SE_B^2 + SE_W^2}.$$

### One-sided significance test for $RD_{max}$

- The statistic for testing  $RD_{max} = 0$  versus  $RD_{max} > 0$  is given by:

$$z = RD_{max} / SE_{RD_{max}}$$

- The maximal rate difference  $RD_{max}$  is statistically significant at the 0.05 level if  $z > 1.64485$ .

### One-sided confidence interval for $RD_{max}$

- The UL is computed as follows:

$$UL = RD_{max} + 1.64485 \times SE_{RD_{max}}.$$

- A 95% confidence interval for  $RD_{max}$  has lower limit = 0.000 and upper limit = UL.

## Maximal rate ratio ( $RR_{max}$ )

### Definition

Using the same notation as above, the maximal rate ratio is defined as:

$$RR_{max} = \max \left\{ \frac{R_B}{R_W}, \frac{R_W}{R_B} \right\}.$$

As with the HP2020 rate ratio  $RR_g$ , note that, regardless of whether the objective is in terms of a favorable outcome to be increased or in terms of an adverse outcome to be reduced,  $RR_{max} \geq 1$ .

### Statistical significance

As with the HP2020 rate ratio  $RR_g$ , when measures of variability are available, the natural logarithm transformation is applied. Using the same notation as above and, again, assuming the two rates are independent, an approximate standard error of the natural logarithm of  $RR_{max}$  is given by:

$$SE_{\ln(RR_{max})} = \sqrt{\left(\frac{SE_B}{R_B}\right)^2 + \left(\frac{SE_W}{R_W}\right)^2}.$$

### One-sided significance test for $RR_{max}$

- Testing  $RR_{max} = 1$  versus  $RR_{max} > 1$  is equivalent to testing

$$\ln(RR_{max}) = 0 \text{ versus } \ln(RR_{max}) > 0.$$

- The statistic for testing  $\ln(RR_{max}) = 0$  versus  $\ln(RR_{max}) > 0$  is given by:

$$z = \ln(RR_{max}) / SE_{\ln(RR_{max})}.$$

- The maximal rate ratio  $RR_{max}$  is statistically significant at the 0.05 level if  $z > 1.64485$ .

### One-sided confidence interval for $RR_{max}$

- As before, the UL is computed via the inverse transformation, as follows:

$$UL = \exp\{\ln(RR_{max}) + 1.64485 \times SE_{\ln(RR_{max})}\}.$$

- A 95% confidence interval for  $RR_{max}$  has lower limit = 1.000 and upper limit = UL.

## HP2020 summary rate ratio ( $RR_{ave}$ )

### Definition

Given that there are  $K - 1$  groups other than the one identified as having the best group rate, compute their average rate  $R_A$  by using the following summation formula:

$$R_A = \frac{R_1 + R_2 + \dots + R_{K-1}}{K - 1}.$$

Continuing with the same notation as previously described, the HP2020 summary rate ratio is defined as:

$$RR_{ave} = \max \left\{ \frac{R_B}{R_A}, \frac{R_A}{R_B} \right\}.$$

As with the HP2020 rate ratio  $RR_g$  and the maximal rate ratio  $RR_{max}$ , irrespective of the objective's directionality, the HP2020 summary rate ratio  $RR_{ave}$  is such that  $RR_{ave} \geq 1$ .

### Statistical significance

In HP2010, the statistical significance of the HP2010 summary index of disparity was assessed using resampling techniques because it was not directly available. In HP2020, when measures of variability are available, the evaluation of statistical significance and confidence intervals for the HP2020 summary rate ratio  $RR_{ave}$  proceeds instead according to the following analytic steps:

**Step 1.** Assuming the group rates are independent and that  $K \geq 3$ , the standard error  $SE_A$  of  $R_A$  is evaluated using the following summation formula, which yields an unbiased estimate of  $SE_A$ :

$$SE_A = \sqrt{\frac{SE_1^2 + SE_2^2 + \dots + SE_{K-1}^2}{K - 2}},$$

**Step 2.** Once  $R_A$  and  $SE_A$  are obtained, determining statistical significance of the summary rate ratio  $RR_{ave}$  proceeds as before. The standard error of the natural logarithm of  $RR_{ave}$  is approximately:

$$SE_{\ln(RR_{ave})} = \sqrt{\left(\frac{SE_B}{R_B}\right)^2 + \left(\frac{SE_A}{R_A}\right)^2}.$$

### One-sided significance test for $RR_{ave}$

- Testing  $RR_{ave} = 1$  versus  $RR_{ave} > 1$  is equivalent to testing

$$\ln(RR_{ave}) = 0 \text{ versus } \ln(RR_{ave}) > 0.$$

- The statistic for testing  $\ln(RR_{ave}) = 0$  versus  $\ln(RR_{ave}) > 0$  is computed:

$$z = \ln(RR_{ave}) / SE_{\ln(RR_{ave})}.$$

- The summary rate ratio  $RR_{ave}$  is statistically significant at the 0.05 level if  $z > 1.64485$ .

### One-sided confidence interval for $RR_{ave}$

- The UL is computed via the inverse transformation:

$$UL = \exp\{\ln(RR_{ave}) + 1.64485 \times SE_{\ln(RR_{ave})}\}.$$

- A 95% confidence interval for  $RR_{ave}$  has lower limit = 1.000 and upper limit = UL.

### Relation to HP2010 summary index

The index of disparity (IDisp) was the single summary measure of health disparities used in HP2010; see [Appendix II](#).

### Objectives expressed in terms of adverse outcomes

For objectives expressed in terms of adverse outcomes to be reduced, the HP2020 rate ratio  $RR_g$  for each of the  $K - 1$  groups other than the “best” group is given by  $RR_g = R_g/R_B$ . Similarly, the HP2020 summary rate ratio  $RR_{ave}$  is given by  $RR_{ave} = R_A/R_B$ . Thus,

$$RR_{ave} = \frac{\frac{1}{K-1} \sum_{g=1}^{K-1} R_g}{R_B} = \frac{\sum_{g=1}^{K-1} RR_g}{K-1}$$

The HP2010 summary index IDisp is obtained by subtracting 1 from the HP2020 summary rate ratio  $RR_{ave}$  and multiplying by 100 when objectives are expressed in terms of adverse outcomes. Indeed:

$$IDisp = \frac{\sum_{g=1}^{K-1} PD_g}{K-1} = \frac{\sum_{g=1}^{K-1} (RR_g - 1) \times 100}{K-1} = (RR_{ave} - 1) \times 100.$$

### Objectives expressed in terms of favorable outcomes

For objectives expressed in terms of favorable outcomes to be increased, the HP2020 rate ratio  $RR_g$  for each of the  $K - 1$  groups other than the “best” group is given by  $RR_g = R_B/R_g$ . Similarly, the summary rate ratio  $RR_{ave}$  is given by  $RR_{ave} = R_B/R_A$ . In HP2010 the percent difference  $PD_g$  and summary index IDisp were calculated using the complementary adverse outcomes, with rates  $\check{R}_B$  and  $\check{R}_g$ . Using the expression for the percent difference  $PD_g$  of the adverse complementary outcomes derived previously, the HP2010 summary index IDisp can be written as:

$$IDisp = \frac{R_B}{\check{R}_B} \times \left( 1 - \frac{1}{K-1} \sum_{g=1}^{K-1} \frac{1}{RR_g} \right) \times 100.$$

Note that the average of the reciprocals of the rate ratios  $RR_g$  in this last expression is not equal to the reciprocal of the average or summary rate ratio  $RR_{ave}$ ; thus, the HP2010

summary index IDisp cannot be directly related to the HP2020 summary rate ratio  $RR_{ave}$  when objectives are expressed in terms of favorable outcomes to be increased.

## Two examples from the HP2020 health disparities tool

The following examples from the HP2020 online health disparities tool, released in spring 2015, serve to illustrate the HP2020 disparities measures; see <http://www.healthypeople.gov>.

### Education disparities in medical insurance for persons aged 25 to under 65, 2013

HP2020 AHS-1.1 objective is to *increase* the proportion of persons with medical insurance. Accordingly, educational attainment groups in [Table 4](#) are sorted from most to least *favorable* outcome; here, that is the percentage of persons aged 25 to under 65 in a given group with medical insurance in 2013.

As in HP2010, HP2020 uses the group with the most favorable (best) rate to highlight opportunities for improvement. Thus, all insurance rates in [Table 4](#) are compared with the best group rate. For example, the ratio 94.8/56.7 between the insurance rate for persons aged 25 to under 65 with an advanced degree (best group rate) and the insurance rate for those with less than a high school education equals 1.671 (see note, below, about rounding); it indicates that the best group rate is 1.671 times the insurance rate among persons aged 25 to under 65 with less than a high school education. Said another way, assuming no other changes, the increase in insurance coverage that would be needed among persons aged 25 to under 65 with less than a high school education to achieve parity with those with an advanced degree (best group) is 67.1% [(1.671 - 1.000) × 100].

**Remark.** All disparity calculations in [Table 4](#) are applied to the unrounded values of the estimates and their standard errors that are available in the HP2020 database. Thus, after rounding to three decimals, values displayed in [Table 4](#) for rate ratios may differ from the results of calculations that use the displayed values of the estimated rates in [Table 4](#). This departs from HP2010, where rounded “display” values were used in disparity calculations (3).

In particular, working with the unrounded values of the estimates and their standard errors (when available) allows more possibilities for breaking ties in the ranking of rates from highest to lowest. For example, if, even after comparing the rates using their unrounded values, two groups are tied for the highest, most favorable rate, the group with the smaller standard error is selected as the “best” rate when measures of variability are available. (If measures of variability are unavailable, then a tie in the unrounded values of two rates may be resolved using group size or any other characteristic;

**Table 4. Persons with medical insurance (percentage, aged 25 to under 65) by educational attainment: United States, 2013**

Educational attainment	Percent	Disparity	Disparity statistically significant
Advanced degree	94.8 CI 94.1/95.5 SE 0.348	× 1.000	...
4-year college degree	90.3 CI 89.6/91.0 SE 0.352	× 1.049 CI 1.000/1.059	Yes
Associate's degree	83.7 CI 82.6/84.8 SE 0.560	× 1.132 CI 1.000/1.146	Yes
Some college	80 CI 79.0/81.0 SE 0.525	× 1.185 CI 1.000/1.200	Yes
High school	75.4 CI 74.4/76.3 SE 0.491	× 1.258 CI 1.000/1.274	Yes
Less than high school	56.7 CI 55.0/58.4 SE 0.870	× 1.671 CI 1.000/1.715 <i>Maximal rate ratio</i>	Yes
<i>Average group rate excluding best group rate</i>	77.2 SE 0.654	× 1.227 CI 1.000/1.246 <i>Summary rate ratio</i>	Yes
<i>Maximal rate difference (in percentage points)</i>	...	38.1 CI 0.0/39.3 SE 0.741	Yes

... Category not applicable.

NOTES: CI is 95% confidence interval; SE is standard error. Data are for HP2020 objective AHS-1.1: Increase the proportion of persons with medical insurance. The calculations of the HP2020 rate ratio as well as the three HP2020 measures of overall disparity, namely the maximal rate difference, the maximal rate ratio, and the HP2020 summary rate ratio, are as described previously. The statistical significance of the HP2020 rate ratio and measures of overall disparity is based on one-sided significance tests at the 0.05 level of significance. Similarly, the CIs for the HP2020 rate ratio and measures of overall disparity are one-sided 95% CI.

DATA SOURCE: CDC/NCHS, National Health Interview Survey.

the HP2020 summary measures, described above, are not affected by group size).

In addition, unlike in HP2010, the identification of the best group rate in HP2020 does not require the 10% threshold for its RSE; see “Motivation for adopting revised disparities measures in HP2020” and (4) for more information.

In Table 4, disparities are examined using the rate ratios between the best (most favorable) group rate and each of the other (less favorable) group rates.

### Comparisons to the best group rate

In 2013, the best group rate by educational attainment for objective AHS-1.1 was realized by persons aged 25 to under 65 with an advanced degree. The best group rate was:

- 1.049 times the rate among persons aged 25 to under 65 with a 4-year college degree
- 1.132 times the rate among those with an Associate’s degree
- 1.185 times the rate among those with some college education
- 1.258 times the rate among those with a high school degree
- 1.671 times the rate among those with less than a high school education

### HP2020 measures of overall disparity

Instead of reporting all pairwise comparisons relative to the best group rate, three measures provided in Table 4 allow for an overall assessment of disparities by educational attainment for objective AHS-1.1:

- *Maximal rate difference.* The absolute (or range) difference between the highest and lowest group rates was 38.1 percentage points in 2013.
- *Maximal rate ratio.* The highest group rate was 1.671 times the lowest group rate in 2013.
- *HP2020 summary rate ratio.* In 2013, the best group rate was 1.227 times the average rate for all other educational attainment groups (excluding the best), 77.2%.

### Racial and ethnic disparities in infant mortality, 2011

HP2020 objective MICH-1.3 is to *reduce* the rate of all infant deaths within 1 year of a live birth. Thus, racial and ethnic groups in Table 5 are sorted from least to most *adverse* outcome. As before, comparisons are relative to the best group rate. For example, the ratio 11.5/4.4 between the infant death rate among non-Hispanic black mothers and the infant death rate for Asian or Pacific Islander mothers (best group rate) equals 2.625 (see note, above, about rounding); it indicates that the former is 2.625 times the best group rate. Thus, assuming no other changes, the infant death rate among non-Hispanic black mothers would need to be reduced by 61.9% [ $100 \times (1 - 1/2.625)$ ] to achieve parity with the best group rate.

In Table 5, disparities are examined using the rate ratios between each of the other (more adverse) group rates and the best (least adverse) group rate.

### Comparisons to the best group rate

In 2011, the best group rate by race and ethnicity for objective MICH-1.3, 4.4 infant deaths per 1,000 live births, was attained by infants born to Asian or Pacific Islander mothers.

- The rate for those born to non-Hispanic white mothers was 1.162 times the best group rate.
- The rate for those born to Hispanic or Latina mothers was 1.181 times the best group rate.
- The rate for those born to American Indian or Alaska Native mothers was 1.882 times the best group rate.
- The rate for those born to non-Hispanic black mothers was 2.625 times the best group rate.

### HP2020 measures of overall disparity

As before, three measures provided in Table 5 allow for an overall assessment of disparities by mother’s race and ethnicity for objective MICH-1.3:

- *Maximal rate difference.* The absolute (or range) difference between the highest and lowest group rates was 7.1 deaths per 1,000 in 2011.
- *Maximal rate ratio.* The highest group rate was 2.625 times the lowest group rate in 2011.
- *HP2020 summary rate ratio.* In 2011, the average rate for all other race and ethnicity groups (excluding the best), 7.5 infant deaths per 1,000 live births, was 1.712 times the best group rate.

### Changes in health disparities over time in HP2020

In HP2020, changes in disparities over time are assessed principally for the three measures of overall disparity described above, although changes in disparities for specific groups relative to the best rate also may be tracked over time as long as the group with the best rate remains unchanged.

As stated earlier, tracking the maximal rate difference  $RD_{max}$  over time allows the analyst to evaluate overall progress toward eliminating disparities, because as the absolute difference between the highest and lowest rates decreases toward 0, all of the pairwise absolute differences between population subgroups will tend to 0. Similarly, as the maximal rate ratio  $RR_{max}$  decreases toward the value 1.000, all of the pairwise rate ratios between population subgroups will tend toward the value 1.000.

The HP2020 summary rate ratio extends the HP2010 index of disparity and focuses on a ratio between the best group rate and the average for all other population groups for a demographic or socioeconomic characteristic. The HP2020 summary rate ratio is more conservative than the maximal rate ratio. For example,  $RR_{ave}$  may remain less than 1.100 even if  $RR_{max} \geq 1.100$ , indicating that, while the highest rate is at least 10% higher than the lowest rate, intermediate rates may be at (near) parity with the best group rate. On the other hand, if the HP2020 summary rate ratio  $RR_{ave} \geq 2.000$ , then the

**Table 5. All infant deaths (per 1,000 live births, under age 1 year), by race and ethnicity: United States, 2011**

Race and ethnicity	Rate per 1,000 live births	Disparity	Disparity statistically significant
Asian or Pacific Islander	4.4 CI 4.1/4.6 SE 0.131	÷ 1.000	...
White, not Hispanic or Latino	5.1 CI 5.0/5.2 SE 0.049	÷ 1.162 CI 1.000/1.224	Yes
Hispanic or Latino	5.2 CI 5.0/5.3 SE 0.075	÷ 1.181 CI 1.000/1.247	Yes
American Indian or Alaska Native	8.2 CI 7.4/9.0 SE 0.422	÷ 1.882 CI 1.000/2.075	Yes
Black or African American, not Hispanic or Latino	11.5 CI 11.2/11.7 SE 0.141	÷ 2.625 CI 1.000/2.768 <i>Maximal rate ratio</i>	Yes
<i>Average group rate excluding best group rate</i>	7.5 SE 0.262	÷ 1.712 CI 1.000/1.847 <i>Summary rate ratio</i>	Yes
<i>Maximal rate difference (in deaths per 1,000)</i>	...	7.1 CI 0.0/7.4 SE 0.192	Yes

... Category not applicable.

NOTES: CI is 95% confidence interval; SE is standard error. Data are for HP2020 objective MICH-1.3: Reduce the rate of all infant deaths (within 1 year). Race and ethnicity is that of the mother. The calculations of the HP2020 rate ratio as well as the three HP2020 measures of overall disparity, namely the maximal rate difference, the maximal rate ratio, and the HP2020 summary rate ratio, are as described previously. The statistical significance of the HP2020 rate ratio and measures of overall disparity is based on one-sided significance tests at the 0.05 level of significance. Similarly, the CIs for the HP2020 rate ratio and measures of overall disparity are one-sided 95% CI.

DATA SOURCE: CDC/NCHS, Linked Birth/Infant Death Data Set.

highest rate is at least twice the lowest rate, a finding that may motivate action to address disparities among the underlying population groups. Highlighting such findings becomes useful as the HP2020 initiative assesses progress toward its overarching goal of eliminating disparities.

When measures of variability are available, the evaluation of the statistical significance of changes in the three HP2020 measures of overall disparity—as well as changes in the HP2020 rate ratios when the group with the best rate remains unchanged—follows from the standard error calculations detailed previously. The natural logarithm transformation may be used, as appropriate, to correct for lack of normality. The difference between the values  $S_1$  and  $S_2$  of measure  $S$  at two time points is tested using a two-sided 0.05-level test based on the statistic

$$z = \frac{S_2 - S_1}{\sqrt{SE_1^2 + SE_2^2}}$$

## Considerations

Findings of health disparities in HP2020 remain subject to the following considerations:

- The HP2020 rate ratio  $RR_g$  is constructed in such a way that its numerical value remains greater than or equal to one regardless of whether an objective is expressed in terms of a favorable outcome or its complementary adverse outcome. Nonetheless, the substantive interpretation of the HP2020 rate ratio changes with the directionality of the objective:
  - For objectives expressed in terms of *adverse* outcomes, the HP2020 rate ratio  $RR_g$  expresses the factor by which the rate for the comparison group  $g$  would need to be *divided* to achieve parity with the best group rate. For objectives expressed in terms of *favorable* outcomes, the HP2020 rate ratio  $RR_g$  expresses the factor by which the rate for the comparison group  $g$  would need to be *multiplied* to achieve parity with the best group rate.
  - In particular, as seen above, whereas the mathematical relationship between the HP2020 rate ratio  $RR_g$  and the HP2010 percent difference  $PD_g$  relative to the best group rate is *linear* for objectives expressed in terms of *adverse* outcomes, the relationship is *nonlinear* for objectives expressed in terms of *favorable* outcomes.
- Users should be aware that all disparity calculations are based on the unrounded values of the estimates and their standard errors that are available in the HP2020 database. Thus, rate ratios calculated from values displayed in HP2020 data tables may differ from those that use the unrounded values and are found in the online HP2020 disparities tool.
- As stated earlier, working with the unrounded values of the estimates and their standard errors (when available) allows tie-breaking in the ranking of group rates from highest to lowest. For example, if, even after comparing rates using their unrounded values, two groups are tied for the most favorable rate, the group with the smallest standard error is selected as “best” group rate. In addition, unlike in HP2010, the identification of the best group rate does not require the 10% threshold for its RSE.
- The standard error calculations for the HP2020 rate ratio and measures of overall disparity are conditional on the reliability of the observed *rank order* of the groups, including the “correct” identification of groups with highest and lowest rates. Yet, just as in HP2010, the ordering itself is not treated as random, only the rates are. Indeed, the conditional variance of the maximal rate difference  $RD_{max}$  differs from the unconditional variance of the difference  $\max\{R_g\} - \min\{R_g\}$ , where the particular groups that achieve the highest and lowest

rates are not identified in advance. Similar considerations apply to the maximal rate ratio  $RR_{max}$  (in relation to the ratio  $\max\{R_g\}/\min\{R_g\}$ ), as well as to the HP2020 summary rate ratio  $RR_{ave}$ . Related methods for estimating confidence intervals for ranks of rates have been developed (11). Whereas such methods may prove useful in assessing the reliability of group ranks, including the best group rate, they are yet to be implemented in HP2020, due to their computational complexity.

## Conclusion

This Statistical Note documents the HP2020 methodology for measuring progress toward target attainment and the elimination of health disparities.

For HP2020, the “percent of targeted change achieved” still measures movement of objectives that are moving from their baseline toward their targets. However, for objectives moving away from their baselines and targets, the “absolute value of the percent change from baseline” is used to measure movement. In addition, unlike in HP2010, both the extent of the movement and its statistical significance (when measures of variability are available) are used in HP2020 to determine an objective’s progress status (e.g., “improving,” “little or no detectable change,” or “getting worse”).

As in HP2010, all groups composing a population domain (e.g., race and ethnicity, education, or income) are compared with the group with the “best” (i.e., most favorable or least adverse) rate. However, HP2020 uses the ratio instead of the percent difference between the rates. In addition, HP2020 objectives that are expressed in terms of favorable outcomes to be increased no longer need to be re-expressed using the complementary adverse outcomes for comparisons relative to the best group rate. However, whereas the mathematical relationship between the HP2020 rate ratio  $RR_g$  and the HP2010 percent difference  $PD_g$  relative to the best group rate is *linear* for objectives expressed in terms of *adverse* outcomes, the relationship is *nonlinear* for objectives expressed in terms of *favorable* outcomes.

In addition to detailed comparisons to the best group rate, HP2020 provides measures that quantify the degree of disparity overall across all groups composing a population domain. Unlike in HP2010, where a single relative measure, the summary index, was used, HP2020 uses three measures that include both absolute and relative measures of overall disparity: a) the simple difference between the highest and lowest rates, irrespective of intermediate rates; b) the ratio between the highest and lowest rates, irrespective of intermediate rates; c) and a summary rate ratio between the best group rate and the average rate for all other groups in a population domain. However, whereas the HP2010 summary index is obtained by subtracting 1 from the HP2020 summary

rate ratio and multiplying by 100 for objectives expressed in terms of adverse outcomes, the HP2010 summary index and HP2020 summary rate ratio are not directly comparable for objectives expressed in terms of favorable outcomes.

The multipronged approach to measurement of progress toward target attainment and elimination of health disparities in HP2020 addresses some of the complex methodological issues and limitations identified in the past decade as well as elsewhere in the literature.

## Appendix I. Measure of Progress Toward HP2010 Targets

This appendix briefly describes measurement of progress toward target attainment in HP2010, which provided the impetus for developing the HP2020 progress measures presented.

### Classification of objective progress status in HP2010

In HP2010, objectives were classified according to the status of their progress toward or away from their targets; see Table 6. As discussed below, even though informative with regard to the sustainability of change from baseline, the magnitude of the “percent of targeted change achieved”—also referred to as the “progress quotient” (1)—as well as its statistical significance (when measures of variability were available) were not factored into the determination of the objective progress status for HP2010 objectives.

### Determination of objective progress status in HP2010

#### Objectives for which progress could be assessed

##### Target met

HP2010 objectives with at least two data points were categorized as TARGET MET if one of the following scenarios applied:

- When the desired direction was increase, *most recent value*  $\geq$  *HP2010 target*.
- When the desired direction was decrease, *most recent value*  $\leq$  *HP2010 target*.

Similarly, HP2010 objectives with only baseline data were categorized as TARGET MET if one of the following scenarios applied:

- When the desired direction was increase, *baseline value*  $\geq$  *HP2010 target*.

**Table 6. Classification of HP2010 objectives, by progress status**

Objective status	Short explanation
TARGET MET	Target met or exceeded.
IMPROVING	Movement is <i>toward</i> the target.
DEMONSTRATED NO CHANGE	Objective demonstrates no change between the baseline and most recent data point.
GETTING WORSE	Movement is <i>away from</i> the target.
BASELINE ONLY	Baseline data only; progress cannot be assessed (with the exception of objectives which have met or exceeded their targets at the baseline).
DEVELOPMENTAL	Objective is developmental (does not have baseline data).

SOURCE: CDC/NCHS, HP2010 database.

- When the desired direction was decrease, *baseline value*  $\leq$  *HP2010 target*.

##### Improving

HP2010 objectives with at least two data points were categorized as IMPROVING if one of the following scenarios applied:

- When the desired direction was increase, *baseline value*  $<$  *most recent value*  $<$  *HP2010 target*.
- When the desired direction was decrease, *baseline value*  $>$  *most recent value*  $>$  *HP2010 target*.

##### Demonstrated no change

HP2010 objectives with at least two data points were categorized as DEMONSTRATED NO CHANGE if *baseline value* = *most recent value*.

##### Getting worse

HP2010 objectives with at least two data points were categorized as GETTING WORSE if one of the following scenarios applied:

- When the desired direction was increase, *most recent value*  $<$  *HP2020 target* and *most recent value*  $<$  *baseline value*.
- When the desired direction was decrease, *most recent value*  $>$  *HP2020 target* and *most recent value*  $>$  *baseline value*.

#### Extent of movement toward target attainment

For HP2010 objectives that had at least two data points, the “percent of targeted change achieved” was used to quantify progress, unless the target had been met or exceeded

at baseline. The formula for the “percent of targeted change achieved” was as follows:

$$\text{Percent of targeted change achieved} = \frac{\text{Most recent value} - \text{Baseline value}}{\text{HP2010 target} - \text{Baseline value}} \times 100.$$

The “percent of targeted change achieved” expressed the difference between the baseline and the most recent value as a percent of the targeted change between the baseline and the HP2010 target.

HP2010 objectives that had a “percent of targeted change achieved” of 100% or more were categorized as TARGET MET. Objectives that had a positive “percent of targeted change achieved” that was less than 100% were categorized as IMPROVING. Otherwise, as stated earlier, the amount of “percent of targeted change achieved” was not considered for determining progress status.

HP2010 objectives that were moving away from their targets and those whose targets had been exceeded at baseline yielded negative “percent of targeted change achieved” values. Although such negative values were reported in the *Healthy People 2010 Midcourse Review* (2), they were not included in the *Healthy People 2010 Final Review* because of the difficulties that arose in their interpretation (3). Instead, for such objectives, the reader is urged to examine the difference between baseline and most recent values to assess progress.

### Objectives for which progress could not be assessed

HP2010 objectives where the target had been met or exceeded at baseline did not use the “percent of targeted change achieved” when assessing progress because they resulted in infinite and negative values, respectively. These HP2010 objectives were simply categorized as TARGET MET, assuming the most recent data point met or exceeded the target.

Also, developmental HP2010 objectives, which had no data, and baseline-only HP2010 objectives, which only had one data point, were generally not included in assessments of progress. An exception was made for baseline-only HP2010 objectives with targets that had been met or exceeded at baseline; these objectives were categorized as TARGET MET, as stated above.

## Appendix II. Health Disparities Measurement in HP2010

This appendix describes measurement of health disparities and changes in disparities over time in HP2010. The features and limitations of the HP2010 health disparities

measures provided the impetus for developing the HP2020 health disparities measures presented.

## Comparisons to the best group rate in HP2010

### Percent difference

The percent difference (PD) was used for comparisons to the best group rate in HP2010.

### Definition

The formula for the percent difference  $PD_g$  from the best group rate for a group  $g$  is as follows:

$$PD_g = \frac{R_g - R_B}{R_B} \times 100,$$

where  $R_B$  is the best group rate and  $R_g$  is the rate for group  $g$  for a particular characteristic.

Some HP2010 objectives were expressed in terms of favorable outcomes that were to be increased, whereas others were expressed in terms of adverse outcomes that were to be reduced. To facilitate comparison of disparities across different HP2010 objectives, the PD was measured only for adverse outcomes in HP2010; as a result, the PD remained nonnegative. Those dichotomous objectives that were expressed in terms of favorable outcomes were re-expressed using the complementary adverse outcome for the purpose of computing the PD, although they were not otherwise restated or changed (3,4).

For example, HP2010 objective 1-1, to increase the proportion of persons with health insurance (e.g., 72% of the American Indian or Alaska Native population under 65 had health insurance in 2008), was expressed in terms of the percentage of persons without health insurance (e.g.,  $100\% - 72\% = 28\%$  of the American Indian or Alaska Native population under 65 did not have health insurance in 2008) when the PD was calculated (3).

### Statistical significance

When measures of variability were available, the statistical significance of the simple difference  $R_g - R_B$  between the group rates was assessed using the following statistic:

$$z = \frac{R_g - R_B}{\sqrt{SE_g^2 + SE_B^2}},$$

where  $SE_g$  was the standard error of the rate for group  $g$  and  $SE_B$  was that of the best group rate.

This formula assumes the two groups are independent. Because the difference  $R_g - R_B$  remained nonnegative, a one-tailed test was employed to assess statistical significance. When  $z > 1.64485$ , the simple difference  $R_g - R_B$  between the two group rates was statistically significant at the 0.05 level.

In HP2010, when the simple difference  $R_g - R_B$  between the two group rates was statistically significant at the 0.05 level, the percent difference  $PD_g$  for group  $g$  relative to the best group rate was flagged, even though the latter was not tested directly (1).

## HP2010 measure of overall health disparity

### HP2010 summary index (“Index of Disparity”)

When more than two groups are associated with a given population characteristic, such as race and ethnicity, income, or education, a summary index provides an assessment of overall disparity at a point in time and whether, overall, disparities are increasing or decreasing.

#### Definition

The formula for the HP2010 summary index, also known as the index of disparity (IDisp), is:

$$\text{IDisp} = \frac{\sum_{g=1}^{K-1} PD_g}{K-1},$$

where  $PD_g$  is the percent difference from the best group rate for each of the groups of interest ( $g = 1, 2, \dots, K$ ), and  $K$  is the number of groups composing the population domain of interest (1,5).

#### Standard error

When measures of variability were available, the standard error of the HP2010 summary index was evaluated using a resampling procedure. This procedure used the rate and standard error for each group to re-estimate each group rate 25,000 times assuming a random normal distribution. Based on these group rates, 25,000 estimates of the summary index were generated, and the distribution of these estimates was used to estimate the standard error of the summary index (1).

## Changes in health disparities over time in HP2010

When data beyond the baseline were available, change in the PD over time was estimated by subtracting the PD at baseline from the PD at the most recent data point. The change was expressed in percentage points: positive differences represented an increase in disparity, and negative differences represented a decrease in disparity.

## Change in percent difference over time for specific groups

Comparisons over time were made only when data were available for the same groups defined in the same way at the baseline and most recent data points. In particular, the group with the best rate was required to remain unchanged for comparisons of the PD over time to be meaningful (3).

### Statistical significance

When measures of variability are available, several steps are required to evaluate statistical significance of a change in the PD over time (1):

**Step 1.** The PD is rewritten in terms of the simple difference  $SD_g = R_g - R_B$  between the rates:

$$PD_g = \frac{SD_g}{R_B} \times 100,$$

**Step 2.** The relative standard error (RSE) of the ratio in the above expression is computed based on the RSE of the numerator and the denominator. The RSE for the numerator,  $SD_g$ , is calculated as:

$$\text{RSE}_{SD_g} = \frac{\sqrt{\text{SE}_g^2 + \text{SE}_B^2}}{R_g - R_B},$$

**Step 3.** The RSE of the best group rate in the denominator of the above ratio is given by:

$$\text{RSE}_B = \frac{\text{SE}_B}{R_B}.$$

**Step 4.** An approximate RSE for the PD is calculated as follows:

$$\text{RSE}_{PD_g} = \sqrt{\text{RSE}_{SD_g}^2 + \text{RSE}_B^2}.$$

This approximation assumes the simple difference,  $SD_g$ , is independent of the best group rate,  $R_B$ .

**Step 5.** An approximate standard error for the PD is given by:

$$\text{SE}_{PD_g} = \text{RSE}_{PD_g} \times PD_g.$$

**Step 6.** The statistical significance of a change in the PD over time is assessed using the statistic

$$z = \frac{PD_{g,1} - PD_{g,0}}{\sqrt{\text{SE}_{PD_{g,1}}^2 + \text{SE}_{PD_{g,0}}^2}},$$

where  $PD_{g,1}$  is the percent difference at the most recent time point,  $PD_{g,0}$  is the percent difference at baseline,  $\text{SE}_{PD_{g,1}}$  is the

standard error of the percent difference at the most recent time, and  $SE_{PD_{g,0}}$  is the standard error of the percent difference at baseline.

## Change in summary index over time

Comparisons over time were made only when data were available for the same groups defined in the same way at the baseline and most recent data points.

## Statistical significance

The resampling procedure described previously was used to estimate standard errors for the summary index at the baseline and most recent time points (1). When measures of variability were available, the statistical significance of a change in the summary index over time was assessed using the statistic:

$$z = \frac{IDisp_1 - IDisp_0}{\sqrt{SE_{IDisp_1}^2 + SE_{IDisp_0}^2}},$$

where  $IDisp_1$  is the summary index at the most recent time point,  $IDisp_0$  is the summary index at baseline,  $SE_{IDisp_1}$  is the standard error of the summary index at the most recent time point, and  $SE_{IDisp_0}$  is the standard error of the summary index at baseline.

As with the change in the pairwise PD, because the value of the summary index  $IDisp$  could either increase or decrease, a two-tailed test was employed to assess statistical significance: A value of  $|z| > 1.96$  indicated that the change in the summary index was statistically significant at the 0.05 level.

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