Monitoring Progress Toward CDC's Health Protection Goals: Health Outcome Measures by Life Stage

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SYNOPSIS

Objectives. From 2004 through 2005, as part of a major strategic planning process called the Futures Initiative, the Centers for Disease Control and Prevention (CDC) developed a set of Health Protection Goals to make the best use of agency resources to achieve health impact. These goals were framed in terms of people, places, preparedness, and global health. This article presents a goals framework and a set of health outcome measures with historical trends and forecasts to track progress toward the Healthy People goals by life stage (Infants and Toddlers, Children, Adolescents, Adults, and Older Adults and Seniors).

Methods. Measurable key health outcomes were chosen for each life stage to capture the multidimensional aspects of health, including mortality, morbidity, perceived health, and lifestyle factors. Analytic methods involved identifying nationally representative data sources, reviewing 20-year trends generally ranging from 1984 through 2005, and using time-series techniques to forecast measures by life stage until 2015.

Results. Improvements in measures of mortality and morbidity were noted among all life stages during the study period except Adults, who reported continued declining trends in perceived health status. Although certain behavioral indicators (e.g., prevalence of nonsmokers) revealed steady improvements among Adolescents, Adults, and Older Adults and Seniors, prevalence of the healthy weight indicator was declining steadily among Children and Adolescents and dramatically among Adults and Older Adults and Seniors.

Conclusion. The health indicators for the Healthy People goals established a baseline assessment of population health, which will be monitored on an ongoing basis to measure progress in maximizing health and achieving one component of CDC's Health Protection Goals.

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In 2003, the Centers for Disease Control and Prevention (CDC) initiated a major strategic planning process called the Futures Initiative, which resulted in a reorganization of CDC's structure and development of CDC's Health Protection Goals.¹ The goals were categorized by four themes—Healthy People in Every Stage of Life, Healthy People in Healthy Places, People Prepared for Emerging Health Threats, and Healthy People in a Healthy World—each with an overarching goal, supported by three to seven strategic goals.² Development of these agency-wide goals required substantial time and careful consideration, and the process greatly benefited from internal and external input. Currently, specific objectives, measures, and recommendations are being mapped to these broad goals.² The overall goals process will guide the alignment of CDC's priorities, budget, performance, and work with partners to accelerate health impact and eliminate health disparities.³

CDC's Health Protection Goals build on the experience of three decades of Healthy People initiatives and expand the scope to include preparedness for a broad array of public health threats, a category for healthy places, and a global mission.⁴⁻⁶ These goals, ambitious but attainable, are intended to energize the nation to surpass the otherwise anticipated results. Tracking progress toward attainment requires that the goals be quantifiable and that they be measured. Past trends in population health are used to guide establishment of realistic yet challenging goals for subsequent decades. Achievement of these goals is dependent, in part, on the ability to monitor progress, evaluate change, and take action where and when needed.

The Healthy People goals are organized by life stage, an approach that dates back to the 1979 U.S. Surgeon General's first report on health promotion and disease prevention.⁷ The life-stage categories by age are Infants and Toddlers, 0–3 years; Children, 4–11 years; Adolescents, 12–19 years; Adults, 20–49 years; and Older Adults and Seniors, ≥50 years. The five life-stage-specific goals are designed to achieve the overarching goals of improving length and quality of life and eliminating health disparities.

To measure progress toward each of these life-stage goals, a set of health outcome measures was needed to capture the complex and multidimensional components of health, including mortality, morbidity, perceived health, and behaviors influencing health during later life stages. This focus on a holistic view of health rather than on specific diseases moves toward the concept of health advanced by the World Health Organization's Ottawa Charter, which defines health as a dynamic resource for living—one that can be mea-

sured in its physical, mental, and social dimensions—to guide health in the future.^{8,9} Given this context, this article presents a set of sentinel health outcome measures with historical trends and forecasts to guide development of quantifiable targets and to measure progress toward the Healthy People goals within CDC's goals framework.

METHODS

The set of health outcome measures was selected to capture multiple dimensions of health, represent both traditional measures of health and perceptions among the population, and track behaviors that can affect health during later life stages. Each measure had to be well-defined and measurable, with sufficient data available for examining trends and producing likely forecasts. Consistency in definition and measurement was maintained, as much as possible, for outcome measures that are similar across life stages. However, certain outcome measures differ across life stages either because of variation in health issues over the life course or differences in data systems supporting the relevant life-stage measures.

Analytic tasks involved identifying the data sources, reviewing trends in outcome measures by life stage, and extrapolating past trends to generate forecasts until 2015. Monitoring health outcomes depends on availability of databases that can provide consistent measures from year to year, thus enabling trend analysis and forecasts that will continue to be available in the future. A key guiding principle was to build on previous methods while standardizing definitions and comparisons so that consistency was maintained regarding federal guidelines and publications, most importantly, *Healthy People 2010*.^{6,10-12} We also used databases that provide national estimates and allow stratification by sex, race/ethnicity, and socioeconomic status for a future article on health disparities. Data sources included nationally representative surveys of the civilian, noninstitutionalized population, and data systems typically ranging from 1984 through 2005. All estimates based on sample surveys incorporated sampling weights and accounted for complex survey design. Strict data suppression criteria limited reporting estimates to those with denominators ≥100 and a relative standard error ≤20%. Health outcome measures by life stage, including data sources, are provided in Table 1.

Forecasts were developed on the basis of previous trends in the health outcome measure. If historical trends were available, univariate time-series forecasts were estimated.¹³ When time-series trends capable of generating projections were unavailable, the most

Table 1. Health outcomes by life stage, actual and forecasts, United States, 1988–2015

	Infants and Toddlers (aged 0–3 years)	Children (aged 4–11 years)	Adolescents (aged 12–19 years)	Adults (aged 20–49 years)	Older Adults and Seniors (aged ≥50 years)
Mortality/healthy life expectancy	Crude death rate ^{a,b} (per 100,000)	Crude death rate ^{a,b} (per 100,000)	Crude death rate ^{a,b} (per 100,000)	Crude death rate ^{a,b} (per 100,000)	Years of life free of limitation ^{c,d}
Actual–1995 ^e /1997 ^f	224.9 ^e	20.0 ^e	61.8 ^e	202.8 ^e	20.1 ⁱ
Actual–2004 ^g /2003 ^h	197.9 ^g	15.1 ^g	49.0 ^g	176.0 ^g	21.6 ^h
Forecast–2010	152.1	11.5	43.5	171.9	22.0 ⁱ
Forecast–2015	113.9	8.6	39.1	168.5	UA ⁱ
Measure of perceived health	Parent- assessed health ^j (percent)	Parent- assessed health ^j (percent)	Parent- assessed health ^j (percent)	Respondent- assessed health ^j (percent)	Respondent- assessed health ^j (percent)
Actual–1995	79.1	79.4	77.2	69.2	45.0
Actual–2005	83.8	81.9	79.6	69.6	47.2
Forecast–2010	84.0	82.4	79.4	68.8	47.7
Forecast–2015	84.2	82.8	78.3	67.9	48.3
Measure of morbidity/ functional limitation	Nonfatal injuries ^k (per 100,000)	No limitations ^j (percent)	No limitations ^j (percent)	No limitations ^j (percent)	No limitations ^j (percent)
Actual–2000 ^l /1995 ^e	13,272 ^j	93.7 ^e	92.0 ^e	88.8 ^e	68.8 ^e
Actual–2005	11,379	92.5	92.7	93.3	76.1
Forecast–2010	UA	91.6 ^{i,m}	92.9 ^{i,m}	94.1 ^{i,m}	76.0 ^{i,m}
Lifestyle measure	NA	Healthy weight ⁿ (percent)	Healthy weight ⁿ (percent)	Healthy weight ⁱ (percent)	Healthy weight ⁱ (percent)
1988–1994 ^o /1995 ^e	NA	84.9 ^o	85.5 ^o	47.6 ^e	40.1 ^e
2003–2004 ^p /2005 ^q	NA	78.6 ^p	79.3 ^p	38.3 ^q	31.1 ^q
Forecast–2010	NA	UA	UA	33.3	28.5
Forecast–2015	NA	UA	UA	28.2	25.6
Lifestyle measure	NA	NA	Smoke-free ^r (percent)	Smoke-free ^j (percent)	Smoke-free ^j (percent)
Actual–1995 ^e /1997 ^f	NA	NA	65.2 ^e	71.6 ⁱ	81.9 ⁱ
Actual–2005	NA	NA	77.0	75.4	84.0
Forecast–2010	NA	NA	UA ⁱ	78.4 ⁱ (74.6, 80.8) ^s	85.8 (79.8, 91.9) ^t

^aCounts of number of deaths obtained from Web-based Injury Statistics Query and Reporting System (WISQARS) provided by the Office of Statistics and Programming, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Data source: National Center for Health Statistics (US). National Vital Statistics System, annual mortality data file, multiple cause-of-death detail, 1982–2004 [cited 2007 Sep 27]. Available from: URL: <http://www.cdc.gov/ncipc/wisqars>

^bCrude death rates were calculated by using mid-year resident population data from the U.S. Census Bureau website, extracted by using SAS for Windows, Version 8 (SAS Institute Inc. SAS: Version 8. Cary [NC]: SAS Institute Inc.; 2000). Data sources: (1) Census Bureau (US). Population estimates, archives [cited 2007 Sep 27]. Available from: URLs: <http://www.census.gov/popest/archives>; http://www.census.gov/popest/archives/1980s/80s_nat_detail.html [1980–1989]; <http://www.census.gov/popest/archives/1990s> [1990–1999]. (2) NCHS (US). Census populations with bridged race categories [cited 2007 Sep 27]. Available from URL: <http://www.cdc.gov/nchs/about/major/dvs/popbridge/popbridge.htm> [2000–2004].

^cAge-specific mortality rates are combined with age-specific morbidity indicator (i.e., proportion with no activity limitation) to produce an estimate of overall healthy life expectancy (i.e., expected years free of limitation). Healthy life expectancy estimates are presented for the years 1997–2003, by coupling the NCHS abridged life tables with the univariate measure of morbidity estimated from the National Health Interview Survey.

^dData sources: (1) NCHS (US). National Health Interview Survey. Survey years, 1997–2003 [cited 2007 Sep 27]. Available from: URLs: http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1997_forward.htm; http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1996_priora.htm. (2) NCHS (US). United States life tables, 1997–2003 [cited 2007 Sep 27]. Available from: URL: <http://www.cdc.gov/nchs/products/pubs/pubd/lftbls/life/1966.htm>

^e1995 data

^f1997 data

^g2004 data

continued on p. 307

Table 1 (continued). Health outcomes by life stage, actual and forecasts, United States, 1988–2015
^h2003 data

ⁱOnly short-run forecasts are provided for measures with shorter time series so that the out-of-sample forecast periods are not longer than that of the historical data being used for the extrapolation.

^jData source: NCHS (US). National Health Interview Survey. Survey years, 1985–2005 [cited 2007 Sep 27]. Available from: URL: http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1997_forward.htm; http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1996_priora.htm. These measures are expressed as favorable outcomes: (a) “respondent-assessed health” is expressed as the proportion reporting very good to excellent health status; (b) data on activity limitation is expressed as the proportion with “no limitations” in activity from chronic physical, mental, or emotional condition; (c) “healthy weight” captures the proportion with normal weight (body mass index, 18.5–24.9); and (d) “smoke-free” measures the proportion who are not current cigarette smokers and are estimated for 1997–2005. Additional supportive estimates are provided for (c) from the National Health and Nutrition Examination Survey, 1999–2004 (available from: URL: <http://www.cdc.gov/nchs/about/major/nhanes/datalink.htm> [cited 2007 Sep 27]).

^kInjury-related morbidity is measured by emergency department visits for injury-related incidents obtained from the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) for 2000–2005. Data source: CDC (US). Web-based Injury Statistics Query and Reporting System (WISQARS), 2005 [cited 2007 Sep 27]. Available from: URL: www.cdc.gov/ncepc/wisqars
^l2000 data

^mOnly the post-1997 data are used in generating the forecasts for “no limitation” because a survey redesign makes the pre- and post-1997 estimates on “no limitation” noncomparable.

ⁿData source: NCHS (US). National Health and Nutrition Examination Survey, years 1976–2004 [cited 2007 Sep 27]. Available from: URL: <http://www.cdc.gov/nchs/about/major/nhanes/datalink.htm>. Not being underweight or overweight represents the proportion with “healthy weight” among the Children and Adolescents life stages, with “healthy weight” being defined as at or above the fifth percentile, but less than the 95th percentile of body mass index for age.

^o1988–1994 data

^p2003–2004 data

^q2005 data

^rData source: CDC (US). Youth Risk Behavior Surveillance Systems, 1991–2005 [cited 2007 Sep 27]. Available from: URL: <http://www.cdc.gov/HealthyYouth/yrbs/data/index.htm>
^sEstimates in parentheses provide forecasts to 2020 for slightly different, but comparable, age groups (18–24 years; 25–44 years), with the extrapolation based on published historical estimates of proportion smoke free (who are not current cigarette smokers) for 1965–2000. Data source: Center for Chronic Disease Prevention and Health Promotion, CDC (US). 1965–2000 [cited 2007 Sep 27]. Available from: URL: http://www.cdc.gov/tobacco/research_data/adults_prev/tab_3.htm. Forecasts for 2001–2020 were estimated using the Holt-Winters method for exponential smoothing.

^tEstimates in parentheses provide forecasts to 2020 for slightly different, but comparable, age groups (45–64 years; ≥65 years), with the extrapolation based on published historical estimates of proportion smoke free for 1965–2000. Data source: Center for Chronic Disease Prevention and Health Promotion, CDC (US). 1965–2000 [cited 2007 Sep 27]. Available from: URL: http://www.cdc.gov/tobacco/research_data/adults_prev/tab_3.htm. Forecasts for 2001–2020 were estimated using the Holt-Winters method for exponential smoothing.

UA = unavailable (forecasts were not reported because of unavailability of consistently measured long time-series, which are necessary for generating reliable out-of-sample forecasts)

NA = not applicable (the outcome measure was not relevant for the particular life stage)

NCHS = National Center for Health Statistics

CDC = Centers for Disease Control and Prevention

recent estimate served as the baseline for the health outcome measure. The Holt-Winters double exponential smoothing method, recommended as being appropriate in circumstances with short time series, was employed in generating the forecasts.¹⁴ This approach is also particularly appropriate for trend fitting, because it is capable of estimating both the current level and trend, where an estimate of the current level consists of a weighted sum of present and previous observations with exponentially decreasing weights assigned to older observations. A version of the Holt-Winters method was used by first estimating the optimal smoothing constants and then using the optimal smoothing parameters for future projections. Only short-run forecasts are provided for measures with

shorter time series so that the out-of-sample forecast periods are not longer than that of the historical data being used for the extrapolation.

Outcome measures by life stage: definition, data, and estimations

Mortality. Crude mortality rates serve as the mortality outcome for the first four life stages. Mortality rates are not age adjusted so that internal consistency is retained across life stages and because certain life stages have age ranges that are too narrow to be appropriate for age adjustment.¹⁵ CDC's National Center for Health Statistics (NCHS) multiple cause-of-death tapes for 1982 through 2004 provided data regarding the number of deaths by life stage.¹⁶ The U.S. Census Bureau's

estimates of the resident population for 1982 through 2004 were used for population denominators.^{17,18}

Healthy life expectancy. For Older Adults and Seniors, expected years free of activity limitation is the selected healthy life expectancy (HLE) measure used as a composite measure of both length and quality of life. Selected from among summary measures recommended by NCHS in the Healthy People 2010 midcourse review, this HLE measure combines age-specific mortality rates with age-specific rates in activity limitation to produce an overall HLE estimate. That estimate indicates the number of years of life free of limitation an average person can expect to live at each age.¹⁹ In this analysis, HLE was estimated for 1997 through 2003 by coupling (using methods described by Sullivan) the NCHS life tables, based on single years of data, with estimates of activity limitation from the National Health Interview Surveys (NHISs).^{20,21}

Perceived health. Respondent-assessed (i.e., self-assessed if aged ≥ 18 years and parent-assessed if aged < 18 years) health is used as an overall perceived health status indicator for all life stages. For Adults aged ≥ 18 years, the percentage of respondents who assess their health as very good or excellent is an indicator of healthiest perceived health. For Children or Adolescents aged < 18 years, the indicator measures the percentage of children whose parents assess them to be in very good or excellent health. Data regarding respondent-assessed health status were estimated from NHISs for 1985 through 2005.²² Of note is that in 1997, the NHIS questionnaire was redesigned, and the collection methodology changed from paper and pencil to computer-assisted personal interviewing. Because of these changes, data from 1997 and later years might not be completely comparable with earlier years.

Functional limitation and morbidity. The proportion of the population with no limitation in age-appropriate activities that results from a chronic physical, mental, or emotional condition serves as a broad measure of functional limitation for all life stages, except Infants and Toddlers. Nationally representative estimates of activity limitation were estimated from NHISs for 1985 through 2005. Because a 1997 survey redesign particularly affected the questions on activity limitation, comparing estimates from before and after 1997 was inappropriate.

Because functional areas, including such domains as cognitive, communication, motor, sensory, emotional, and social, are still developing during the first 36 months of life, activity limitation was not used for Infants and Toddlers. Because fatal and nonfatal injuries represent one of the leading causes of preventable

burden among Infants and Toddlers, trends in nonfatal injuries were used as a measure of morbidity for the Infant and Toddler life stage. Injury-related morbidity was measured by emergency department visits for injury-related incidents obtained from the National Electronic Injury Surveillance System–All Injury Program for 2000 through 2005.²³

Indicators of behavior influencing health during later life stages. Modifiable risk factors (e.g., tobacco use and obesity) are related to multiple chronic conditions and are leading causes of premature mortality.^{24–26} Consequently, prevalence of having healthy weight and being smoke-free are used as the leading indicators to capture trends in positive lifestyle factors that affect the future health of people of all ages.

Healthy weight is measured differently across life stages, depending on whether the person is aged < 20 years or ≥ 20 years. Among Children and Adolescents aged 4 to 19 years, healthy weight is defined as including the fifth to 94th percentile of body mass index (BMI, calculated as weight in kilograms divided by square of height in meters) for age, using the 2000 CDC sex- and age-specific U.S. growth charts.²⁷ The prevalence of healthy weight among Children and Adolescents was estimated using measured BMI from the National Health and Nutrition Examination Survey (NHANES) for 1976 through 2004.²⁸

Among Adults and Older Adults and Seniors (people aged ≥ 20 years), healthy weight is defined as having a BMI of 18.5 to 24.9 and was estimated using NHISs for 1985 through 2005.²⁹ Because BMI estimates from NHISs are based on self-reported height and weight, which might yield somewhat higher estimates of healthy weight, validation was provided with additional estimates using measured BMI in NHANES surveys for 1999–2000, 2001–2002, and 2003–2004.

The proportion of people who are not current cigarette smokers was used as a proxy to generate trends in the proportion of smoke-free Adolescents, Adults, and Older Adults and Seniors. The data for Adolescents were obtained from the Youth Risk Behavior Surveillance System for 1991 through 2005.³⁰ Because routine questions related to cigarette smoking were included in the adult core sample only after the survey redesign in 1997, recent trends in the proportion of smoke-free Adults and Older Adults and Seniors were examined using NHISs for 1997 through 2005. Existing studies covering previous years established a steady decrease in smoking prevalence among Adults and Older Adults and Seniors from 1965 through 1990, which leveled off during the 1990s.³¹ However, comparing pre- and post-1997 trends was not considered appropriate for our study because smoking questions for 1965 through

1996 were only included for selected years in the NHIS special supplements, which had smaller and varying sample sizes.

RESULTS

The health outcome measures by life stage, including selected forecasts until 2015, are presented in Table 1. These forecasts can be used to reflect future trends in the outcome measures under status quo. Although the average life span continued to increase among U.S residents from 1997 through 2003 (Table 2), changes in mortality varied by life stage (Figure 1). Although crude mortality rates have decreased since 1982 among Infants and Toddlers, Children, and Adolescents and are projected to continue to decrease through 2015, the rates for the Adults life stage revealed a slow upward trend until the mid-1990s, followed by a sharp decline from 1995 through 1997, with minor variation in trends from 1998 through 2004. Among Older Adults and Seniors, increases in life expectancy have been accompanied by slow and steady increases in healthy life expectancy. From 1997 through 2003, expected years free of limitation estimated at ages 50, 65, and 75 years (Table 2) showed an upward but slowing trend in healthy life expectancies.

Examination of trends in respondent-assessed health status indicated that the proportion reporting very good or excellent health has increased rapidly among the Infants and Toddlers and Children life stages, has remained relatively stable among Adolescents, has declined among Adults, and has increased slowly among Older Adults and Seniors (Figure 2). In addition, the percentage of people reporting very good or

excellent health declined sharply with age, with the most rapid change occurring at the transition from the Adults to the Older Adults and Seniors life stage (Figure 2). Although the 1997 survey redesign did not change the survey question on self-assessed health, the redesign still affected the estimate, as reflected by the increase in trends in 1997 across all life stages.

Throughout all life stages for those aged <50 years, the percentage of people with no reported limitation from chronic conditions was relatively stable and consistently >88% from 1985 through 2005 (Figure 3). The percentage of Older Adults and Seniors with no limitation from chronic conditions was <77%. Trends in no activity limitation among Older Adults and Seniors depicted gradual improvements with time. Among Infants and Toddlers, trends in nonfatal injury declined steadily from 13,272 injuries per 100,000 population in 2000 to 11,379 per 100,000 population in 2005 (Table 1).

Recent trends in prevalence of smoke-free Adults and Older Adults and Seniors revealed gradual improvements from 1997 through 2005 (Figure 4). Among Adolescents in grades 9 through 12, a decline in the proportion of those who were smoke-free from 1991 through 1997 (from 72.5% to 63.6%) had a sharp reversal after 1997, with sustained annual increases until 2003 (to 78.1%), followed by a recent decline noted in 2005 (to 77.0%).

NHANES estimates indicated that prevalence of healthy weight declined from 87.9% to 78.6% for Children and from 91.3% to 79.3% for Adolescents from 1976–1984 to 2003–2004 (Figure 5). NHIS estimates revealed that from 1985 through 2005, prevalence of healthy weight declined from 56.6% to 38.3% among

Table 2. Healthy life expectancy,^a 1997–2003, Older Adults and Seniors (aged ≥50 years)

	1997	1998	1999	2000	2001	2002	2003
At age 50 years:							
Life years remaining	29.7	29.8	29.8	30.0	30.3	30.3	30.6
Expected years free of limitation	20.1	20.8	21.1	21.4	21.5	21.5	21.6
At age 65 years:							
Life years remaining	17.7	17.8	17.7	17.9	18.1	18.2	18.4
Expected years free of limitation	10.1	10.7	10.9	11.2	11.3	11.4	11.5
At age 75 years:							
Life years remaining	11.2	11.3	11.2	11.3	11.5	11.5	11.8
Expected years free of limitation	5.2	5.6	5.7	5.8	5.9	5.9	6.1

Data sources: (1) National Center for Health Statistics (US). National Health Interview Survey, 1997–2003 [cited 2007 Sep 27]. Available from: URL: http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1997_forward.htm; (2) NCHS (US). United States life tables, 1997–2003 [cited 2007 Sep 27]. Available from: URL: <http://www.cdc.gov/nchs/products/pubs/pubd/lftbls/life/1966.htm>

^aHealthy life expectancy estimates were computed by coupling age-specific mortality rates from the NCHS abridged life tables with an age-specific morbidity indicator (i.e., proportion with no activity limitation) estimated from the National Health Interview Surveys.

NCHS = National Center for Health Statistics

Figure 1. Trends in crude death rate by life stage, United States, 1982–2015, actual^a and forecast^b

^aMortality rate from 1982 to 2004 calculated using National Center for Health Statistics annual mortality data file and U.S. Census Bureau population estimates

^b2005–2015 forecasts estimated using the Holt-Winters method for exponential smoothing

Adults and from 43.8% to 31.1% among Older Adults and Seniors. Estimates of healthy weight in NHANES surveys from 1999–2000, 2000–2001, and 2003–2004 ranged from 35.0% to 37.0% among Adults and from 27.0% to 28.0% among Older Adults and Seniors, which were slightly lower but approximated the NHIS estimates.

DISCUSSION

Establishing measurable national health objectives focused on disease and injury prevention and reduction of premature mortality has been a critical strategy for improving and protecting public health in the U.S. since the 1970s.⁷ The Healthy People in Every Stage

of Life component of CDC's new Health Protection Goals measures improvements in health and quality of life using broad positive measures.² The overall goals framework reflects the Institute of Medicine's recommendation that a short list of health status and risk-reduction measures, along with appropriate performance measures, will lead to a clearer focus on national health.^{32,33} CDC's short list of goals and associated outcome measures will track improvements in health status and healthy behaviors, guiding the agency's activities, its work with partners, and the allocation of its resources.

CDC is constructing the goals framework to be compatible with Healthy People 2010 and the Office of Management and Budget's performance assessment

Figure 2. Proportion of the population reporting "very good" or "excellent" health, by life stage, United States, 1985–2015, actual^a and forecast^b

^aPast trends estimated from the National Health Interview Surveys, 1985–2005

^b2006–2015 forecasts estimated using the Holt-Winters method for exponential smoothing

rating tool so that the agency will have one cohesive approach for targeting its resources and monitoring its progress.^{34,35} Efforts are also underway to retain consistency with past initiatives. While the Healthy People 2010 Leading Health Indicators (LHI) continue to be relevant in monitoring overall population health, the current Healthy People goals provide a complementary approach for monitoring health by life stage.³⁶ To ensure historical continuity and compatibility across these two approaches, the LHI objectives are being used to help develop underlying objectives for the Healthy People goals. Creating a set of health outcome measures for the life-stage goals is one step toward establishing a goals-based performance system. Further research is needed to make all goals measurable by developing measures for the places, preparedness, and global goals.³⁷

While the forecasting approach presented in this article can guide the development of attainable but ambitious targets, target-setting will require extensive

programmatic and stakeholder input as well. Analytic support is needed to develop links between the measures of burden and program areas (e.g., healthy life expectancy and cancer prevention and control) for which objectives and performance measures are being developed. For example, CDC's immunization programs set specific immunization objectives that are critical for continued progress toward eliminating vaccine-preventable childhood diseases, which will eventually lead to improved health outcomes for children.

CDC goal teams, comprising experts from inside the agency, are working with external partners to develop objectives, measures, and recommendations for aligning CDC programs with the goals.¹ Eventually, this will provide a cohesive framework that maps all program activities to the agency's overarching goals and broad mission. However, it is important to acknowledge that the health-status measures described in this article are not in themselves measures of CDC's performance;

Figure 3. Proportion of the population reporting no limitation in activity, by life stage, United States, 1985–2005

Data source: National Health Interview Surveys, 1985–2005

^aComparing estimates from before and after the 1997 survey redesign is considered inappropriate because it particularly affected questions on activity limitation.

Figure 4. Proportion of the population who are not current cigarette smokers, by life stage

Data source: Youth Risk Behavioral Surveillance Systems, 1991–2005

Data source: National Health Interview Surveys, 1997–2005

Data source: National Health Interview Surveys, 1997–2005

Figure 5. Proportion of the population with healthy weight^a by life stage, actual^b and forecast^c

Data source: NHANES, 1976–2004

NOTE: Weight categories are based on 2000 sex- and age-specific growth charts for the U.S. Healthy weight is defined as not underweight, at risk of being overweight, or overweight (i.e., fifth percentile $\leq$ age- and sex-specific body mass index <95th percentile). ^aHealthy weight is defined as having a body mass index of 18.5 to 24.9.^bPast trends estimated from the National Health Interview Surveys, 1985–2005^c2006–2015 forecasts estimated using the Holt-Winters method for exponential smoothing

NHANES = National Health and Nutrition Examination Survey

improving trends toward goal attainment might certainly reflect CDC's contribution, but captures the effect of other factors including the contribution of other key players and partners.

Challenges

Although this is the first article to present a broad, unified framework for monitoring the Healthy People goals, multiple approaches are necessary for developing measurable goals and evaluating activities in support of the overall process. Developing this set of health outcome measures within the framework of the five life stages presented numerous methodological challenges. Because certain life stages have broad age ranges, substantial variation might exist in health risks by age within such age groups. Likewise, in defining the healthy weight indicator, multiple BMI categories with possible variations in health risks were grouped together. For particular programmatic needs, subgroup outcome measures (e.g., infant mortality or premature mortality for people aged 50 to 64 years) and behavioral indicators (e.g., physical activity or diet) will be used for measuring progress toward specific life-stage objectives. In addition, age-adjusted estimates will be monitored by goal action teams to assess the impact of targeted programs and activities.

Crude estimates, not adjusted for age, were used for the majority of measures (except HLE, which is an age-standardized measure independent of the age distribution) to maintain consistency in measures across life stages, as well as to retain the impact of aging. The implication of this approach must be highlighted for Older Adults and Seniors (≥ 50 years) because it masks considerable variation in health status that exists within this age group as well as the rapid impact of the changing age distribution over time. In addition, the growing share of minorities (e.g., Hispanic people) in the overall population is likely to affect the sentinel outcomes. Assessing the extent and impact of aging as well as other demographic (e.g., race/ethnicity) changes on risk factors and disease burden is critically important, but for appropriate policy relevance, they merit a separate, more comprehensive analysis.^{38,39}

Availability of data systems and historical data were among the criteria for selection of health outcome measures; thus, outcomes supported by data that did not meet these criteria were not included. For example, available data systems do not provide optimal general measures of morbidity for Children and Adolescents. Recognition of major data gaps should emphasize the need for investment in measures development, including data systems to track them at the national, state, and local levels. Continued investment in surveys that

can provide timely public-use data for comparable state- and county-level estimates is critical for ensuring participation of state and local public health agencies in tracking progress toward these goals.

Because of limited historical data for certain health outcome measures, forecasting was restricted to univariate time-series analyses. This restriction limits interpretation of the underlying associations among variables and assumes that both the variation in and the effect of exogenous variables is expressed in the past behavior of the series. The implication of this assumption is pertinent, particularly for mortality forecasts, because the life expectancy gains experienced from 1982 through 2004 are expected to exhibit diminishing returns in the future. Consequently, mortality targets that are challenging but attainable are likely to be below the projected forecasts. Thus, if conditions under which the past data were generated remain the same, this method will provide reasonably accurate short- and medium-term forecasts. Forecasts should be updated periodically to incorporate the impact of systemic changes (e.g., new technologies, epidemics, or wars) and other temporal changes (e.g., aging and increasing racial/ethnic diversity) in underlying conditions.

Further research is needed for improved summary measures of population health. The simple measure of respondent-assessed health status was chosen because of its validated reliability and its utility as a valid predictor of future health events, including death.⁴⁰ In contrast, identifying the best construct for measuring healthy life expectancy is complex, but supported by active research that explores development of new multidimensional summary measures. The HLE measure was chosen because of its ability to continually monitor healthy life expectancy in the U.S., but it might be supplanted by improved measures of healthy life expectancy developed in this evolving field.

CONCLUSION

The health outcome measures presented in this article are, by nature, lagging indicators of progress toward CDC's life-stage goals. Because health consequences follow actions with variable time lags, the effects of health-protection activities implemented in 2005 might not be detected until well beyond 2010. Thus, leading indicators that can be measured on an annual or semiannual basis also should be developed. CDC's performance measures should be reevaluated regularly to adapt to the availability of new technologies (e.g., drug discoveries or new vaccines) and unpredictable externalities (e.g., natural disasters, pandemics, or economic recessions) that ultimately can affect progress

toward CDC's Health Protection Goals. Adherence to goals and tracking performance will give CDC and its partners the ability to modify programs and redirect resources in a timely manner while maintaining a focus on the desired medium- and long-term health impacts of public health investments.

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