Articles

Potential Health Economic Benefits of Vitamin Supplementation

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This study used published relative risk estimates for birth defects, premature birth, and coronary heart disease associated with vitamin intake to project potential annual cost reductions in U.S. hospitalization charges. Epidemiological and intervention studies with relative risk estimates were identified via MEDLINE. Preventable fraction estimates were derived from data on the percentage of at-risk Americans with daily vitamin intake levels lower than those associated with disease risk reduction. Hospitalization rates were obtained from the 1992 National Hospital Discharge Survey. Charge data from the 1993 California Hospital Discharge Survey were adjusted to 1995 national charges using the medical component of the Consumer Price Index. Based on published risk reductions, annual hospital charges for birth defects, low-birth-weight premature births, and coronary heart disease could be reduced by about 40, 60, and 38%, respectively. For the conditions studied, nearly $20 billion in hospital charges were potentially avoidable with daily use of folic acid and zinc-containing multivitamins by all women of childbearing age and daily vitamin E supplementation by those over 50.

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Preventable illness may account for as much as 70% of U.S. health care costs.[1,2] Research on prevention over the last two decades has focused on the increased cardiovascular risk of high-fat diets and sedentary lifestyles.[3-7] Another aspect of prevention to examine is the research associating vitamin intake and reductions in three costly health care conditions: the association between intake of multivitamins containing folic acid (MVF) and a reduced risk of birth defects; the association between intake of MVF/MVF and zinc (MVF+Z) and a reduced risk of preterm delivery/low birth weight; and the association between intake of supplements containing vitamin E and a reduced risk of coronary heart disease. We describe a method for translating published risk reduction estimates based on vitamin intake into estimates of potential savings from avoidable U.S. hospitalizations.

Methods and Data Sources

Risk Reduction From Vitamins and Preventable Fraction of Disease

We used MEDLINE to search the published literature (as of May 4, 1996) about vitamins relevant to the diseases/outcomes of interest. Studies were classified by type of nutrient, study design, and characteristics of study population. Estimates of the preventable fraction of disease were derived from studies that 1) contained relative risk estimates of the association between vitamin intake and disease incidence, 2) measured the association of disease risk with vitamin intake rather than with blood/plasma level of the nutrients, and 3) had end-points that could be coded using specific ICD-9-CM (*The International Classification of Diseases*, 9th Revision, Clinical Modification) categories. Relative risk (RR) estimates on each vitamin–disease association included at least one randomized controlled trial.

RR estimates of vitamin intake from the selected studies were used to develop a range of estimated beneficial effects for each condition. Vitamin benefits are defined in terms of the preventable fraction (PF) of disease, also known as the population-attributable risk of disease.[8] To translate a given RR estimate of vitamin supplementation into a PF, an intervening measure was developed—prevalence of vitamin-associated risk (PVAR)—to reflect the percent of the population with vitamin intake below the level found, in the peer-reviewed, published literature, to consistently reduce disease risk. This measure is analogous to the concept of prevalence of a given risk factor (physical inactivity, smoking) used in other studies of population-attributable risk.[9,10] For a beneficial "risk" factor such as vitamin intake, the preventable fraction measures the proportion of disease incidence in the population that could have been prevented if the percentage of population at vitamin-associated risk (PVAR) had had

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ABBREVIATIONS USED IN TEXT

AMI = acute myocardial infarction
CABG = coronary artery bypass graft
CHD = coronary heart disease
CPI = Consumer Price Index
ICD-9-CM = *The International Classification of Diseases,* 9th Revision, Clinical Modification
LBW = low birth weight
MVF = multivitamins containing folic acid
MVF+Z = multivitamins containing folic acid and zinc
NTD = neural tube defects
PF = preventable fraction
PTCA = percutaneous transluminal coronary angioplasty
PVAR = prevalence of vitamin-associated risk
RR = relative risk
U.S. RDI = U.S. Reference Daily Intake

optimal intake levels of the specific supplements.

$$(1)\ PF = \frac{PVAR\ (IRR - 1)}{1 + PVAR\ (IRR - 1)}$$

where IRR is the inverse of the estimated relative risk associated with the beneficial risk factor, vitamin intake, i.e., 1/RR.

PVAR is a critical measure. Even the most optimistic risk reduction estimated from scientific studies of vitamin intake would have no effect on health status if the nation's population was already at optimal vitamin intake levels, because PVAR and PF would both equal zero (equation 1). Conversely, even modest RR estimates would translate into potential reductions in disease if the population were currently consuming lower than optimal levels of vitamins. When almost no one in the general population is at or above the supplementation levels associated with significant risk reductions in the literature, then PVAR = 1 and PF equals the observed risk reduction, i.e., one minus the estimated relative risk.

$$(2)\ PF = \frac{IRR - 1}{1 + IRR - 1} = 1 - \frac{1}{IRR} = 1 - RR$$

Baseline Measures of Hospitalization for Selected Diseases

To assess the number of hospital discharges for the conditions targeted in this study, we used the National Hospital Discharge Survey (NHDS) 1992.[11] Discharges with primary diagnoses based on the following ICD-9-CM codes were captured: coronary heart disease (ICD-9-CM 410–414), birth defects including cardiovascular defects (ICD-9-CM 745–747), neural tube defects (ICD-9-CM 741), and low birth weight associated with preterm delivery (ICD-9-CM 765). To ensure that hospital charges related to the condition in question, we used only primary diagnoses. In the absence of national hospital charge data, we used the 1993 California Hospital Discharge Database[12] to compute actual charges in Los Angeles and San Francisco counties, then adjusted the charges to a national level. To do so, we determined the ratio of the average urban medical price index in the Los Angeles and San Francisco areas to the national urban price index and applied the ratio to ICD-9-specific hospital charges, thus obtaining national urban charges at 1993 prices.[13] We adjusted these urban charges to the medical component of the Consumer Price Index (CPI) and then to 1995 prices using the change in the national medical CPI between 1993 and 1995.[13] This calculation yielded estimated annual national hospital charges for each condition, expressed in 1995 prices.

Charges for each condition were calculated on average for each discharge and also used in a regression model to obtain predicted charges by demographic and payer categories, thus reflecting demographic differences in utilization and payer-specific charge patterns for each condition.

Preventable Hospitalizations and Charges

To identify potentially preventable hospitalizations and the associated charges for each condition, the PF was multiplied by 1992 U.S. hospital discharges and total charges, yielding an approximate measure of the aggregate expected annual savings from vitamin supplementation in a given population.

Results

Number of Hospital Discharges, Patient Demographics, and Hospital Charges

Neural tube and cardiovascular birth defects. More than 4,600 babies with a primary diagnosis of neural tube defects (NTD) were discharged from U.S. hospitals in 1992, representing $141 million in hospital charges. One leading manifestation of NTD, spina bifida, costs as much as $200 million annually in direct medical costs.[14] The lifetime economic cost to society per person with spina bifida is about $258,000.[15] There are significant regional and racial variations in the incidence of spina bifida, blacks and Asians having significantly lower rates than whites and Hispanics.[16]

Cardiovascular birth defects are the most commonly occurring birth defects. Altogether these accounted for about 60,000 hospital discharges in 1992 (the ICD-9-CM charge code does not differentiate between subsets of cardiovascular birth defects such as conotruncal defects). In 1995, associated charges amounted to nearly $3 billion.

Low birth weight (LBW) associated with preterm delivery. Of the approximately 4 million infants born in the US each year, about 7% or 280,000 have LBW (<2,500 g)[17] and engender higher hospitalization charges than infants weighing >2,500 g at birth. The majority of LBW infants are born preterm; 30,000 infants had LBW as the primary diagnosis in 1995. Their average hospital charges were about $86,000; total charges for this primary condition were about $2.6 billion in 1995. Black infants were overrepresented (21% of all discharges) among LBW newborns, and their average per capita charges were about $108,000 compared with about $76,000 for white infants. About half of these discharges

Table 1.—*Relative Risk of Disease From Vitamin Intake and Preventable Fractions of U.S. Hospitalizations: Birth-Related Disorders*

Primary Diagnosis	*Beneficial Vitamin and Level of Exposure*	*Relative Risk (RR) from Optimal Vitamin Intake* (as defined in col.2)*	*PVAR†*	*PF of Hospitalizations*
NTD (ICD-9-CM 741)	MVF (0.4–0.8 mg of folic acid); daily in periconceptional period[20-24,26]	0.3–0.4	74.1%	52.6–63.4%
Cardiovascular Birth Defects (ICD-9-CM 745–747)	a) MVF (0.4 mg/day of folic acid during periconceptional period)[32-35]	0.53–0.56	74.1%	36.6–39.7%
	b) fortified cereals containing 0.1 mg of folic acid in a daily serving[34]	0.17	25.0%	54.9%
Low Birth Weight due to Preterm Delivery (ICD-9-CM 765)	a) MVF+Z (15–20 mg of zinc) daily during first trimester of pregnancy[19,38-42]			
	All women	0.19–0.82	31.4%	6.7–58.8%
	Black adults		50.9%	10.5–69.8%
	Teenagers		50.0%	10.3–67.4%
	White adults		27.0%	5.8–55.1%
	b) MVF (at least 0.24 mg/day of folic acid during periconceptional period)[42]	0.30	31.4%	42.2%

*All reported RRs are statistically significant at the 95% level.
†In terms of optimal level of relevant vitamin (column 2) and derived from population survey of supplementation.[31]
Superscript numerals refer to the articles in the list of references from which the range of RR estimates are derived.

were paid for by Medicaid, which incurred $1.3 billion in associated charges. Pregnant adolescents are at greater risk of preterm delivery and related problems[18,19] than adults and accounted for associated hospital charges of more than $330 million in 1995.

Coronary heart disease (CHD). Approximately 2.1 million patients with a primary diagnosis of CHD were discharged in 1992 and incurred total hospital charges of $51.8 billion in 1995 prices. Of CHD discharges, 58.5% were men and 54.2% were Medicare enrollees. Given the age and sex distribution of the U.S. population in 1992,[13] the risk of CHD hospitalization varied substantially by age, sex, and race, with men over 50 years old at greatest risk.

One CHD condition, acute myocardial infarction (AMI), accounted for about 738,000 hospital discharges and nearly $22 billion in charges. Most of the AMI discharges were patients over age 50, and an overwhelming majority were men, regardless of age. Men also generated significantly higher charges than women, and men over age 50 accounted for more than half of total AMI charges.

Risk Reduction from Vitamin Supplementation and PF of Hospitalizations

Neural tube and cardiovascular birth defects. Numerous epidemiological studies have shown that daily supplementation with MVF (containing 0.4–0.8 mg folic acid) during the periconceptional period (approximately 3 months before to 3 months after conception) is associated with a significant reduction in risk of NTD.[20-24] In addition, one placebo-controlled intervention study showed that folic acid alone can prevent 70% of the recurrence of NTD births;[25] a second controlled study showed that use of folic acid–containing multivitamins resulted in zero NTD cases in the group taking supplements compared with six cases in the placebo group (a highly significant difference).[26] The data from placebo-controlled trials contradict the argument that the preventive factor is actually some lifestyle or other factor associated with women who choose to use supplements rather than the supplements themselves; placebo-controlled, double-blind studies indicate that the active intervention is the cause of the birth defect risk reduction. The epidemiological studies on populations also found a 60–70% reduced risk of NTD associated with intake of MVF[20-24,27] after adjusting for other risk factors. These studies found, moreover, that when supplementation begins in the third month of pregnancy, it fails to reduce risk.[28] Thus, the March of Dimes and the Centers for Disease Control and Prevention have recommended that all women of child-bearing potential take a daily multivitamin with folic acid daily.[29]

The cumulative data from epidemiologic studies and the data from well-controlled intervention studies also found that dietary intake alone of folate is not consistently associated with reduction in risk of NTD or certain other serious malformations, including cardiovascular birth defects. In two double-blind, placebo-controlled intervention studies, dietary intakes of folate were insufficient to reduce risk; significant risk reduction was only seen when folic acid–containing supplements were provided in addition to dietary folate.[28,30] Moreover, supplementary folic acid is more bioavailable than most naturally occurring folates in foods. Breakfast cereals that are fortified with folic acid, however, are an important dietary source of the vitamin, and intake of fortified cereals has been associated with reduced NTD risk in certain epidemiological studies.[28] The level of total folate intake consistently associated with NTD risk reduction is 0.4–0.8 mg of supplemental folic acid in addition to average dietary folate intakes of 0.15–0.2 mg folate per day.[28]

Table 2.—*Projected Impact of Vitamin Intake on Preventing U.S. Hospitalizations and Charges: Birth-Related Disorders*

Medical Condition	*Preventable Hospitalizations (thousands)*	*Preventable Hospital Charges ($ millions)*	*Preventable Charges (Expected Benefit) per Pregnancy*
NTD*	2.42–2.93	73–89	$11–14
Cardiovascular Birth Defects*	20.7–21.6	1,047–1,135	$161–175
†	32.9	1,607	$247
LBW/Preterm Delivery‡	2–17.6	173–1,519	$27–234
§	12.6	1,097	$169
Blacks	0.65–4.3	70–466	$52–347
Whites	1.4–13.2	103–1,006	$26–252
Teenagers	0.4–2.6	34–223	$35–231

*From optimal daily intake of multivitamins that include 0.4–0.8 mg of folic acid during periconceptional period.
†From a daily serving of folic acid–fortified cereal during periconceptional period.
‡From optimal intake of MVF+Z (zinc at levels of 6–15 mg/day) during first trimester of pregnancy.
§From daily MVF supplementation during first trimester of pregnancy.
Preventable hospital charges are obtained on the basis of preventable fraction of hospitalizations for each condition (Table 2) and 1992 volume of hospital discharges and associated charges nationwide for corresponding conditions (reported in text).

In light of consistent findings that supplements are critical to effective risk reduction, it is important to ascertain the prevalence of MVF supplementation in the population. One nationally representative survey of women receiving prenatal care during the second trimester found that about 80.6% took MVF supplements with U.S. Reference Daily Intake (U.S. RDI) nutrient levels during pregnancy and 25.9% took MVF supplements before pregnancy.[31] Since periconceptional supplementation has been associated with prevention of birth defects, the prevalence of MVF-associated risk reduction was determined to equal 74.1% (100% – 25.9%; Table 1). Table 2 shows that the projected economic effect of prevention would be in the range of $73–89 million a year, given the total number of discharges for 1992.

Based on several population-based case control studies[32–34] that examined cardiovascular and other birth defects as part of Birth Defects Monitoring programs in Atlanta[33] and California[34] and a prospective intervention study of all congenital anomalies in Hungary,[35] there was significant reduction in risk of conotruncal and other cardiovascular birth defects associated with MVF supplementation. Incorporating the 74.1% PVAR derived from periconceptional use of supplements into the RR estimate, potentially preventable hospital charges were more than $1 billion per year (Table 2). Potential total reductions in dollar charges were divided by the approximately 4 million annual births in the U.S.,[13,36] to yield an expected benefit of greater than $200 per pregnancy (Table 2).

The magnitude of preventable cardiovascular birth defects from folic acid–fortified foods was also estimated based on an epidemiological study showing that consumption of breakfast cereal fortified with folic acid was associated with a relative risk of 0.17 (95% CI, 0.02–0.93) for conotruncal heart defects.[34] One 28- to 30-g serving of fortified cereal typically provides 25% (or 0.1 mg) of the U.S. RDI of folic acid.[37] Given known dietary and MVF intake distribution in the population, about 75% of U.S. women of child-bearing age do not consume the U.S. RDI of 0.4 mg folic acid per day; this subset of women could potentially benefit from consuming at least one daily serving of fortified breakfast cereal. Combining the RR and PVAR cited above, 54.9% of all hospitalizations for cardiovascular birth

Table 3.—*Relative Risk of Disease From Vitamin E Intake and Preventable Fractions of U.S. Hospitalizations: Coronary Heart Disease*

Primary Diagnosis	*Beneficial Vitamin and Level of Exposure*	*Relative Risk (RR) from Optimal Vitamin Intake* (as defined in col. 2)*	*PVAR†*	*PF of Hospitalizations*
CHD**				
Men	Vitamin E (sustained supplementation at median level of 419 IU/day for more than 2 years)[41]‡	0.63	73–96%	30–36.1%
Women	Vitamin E (sustained supplementation at median level of 208 IU/day for more than 2 years)[41]‡	0.59	73–96%	33.7–40%
Nonfatal Acute MI	Vitamin E (supplementation at 400–800 IU/day)[43]§	0.23	73–96%	71–76.3%

*All reported RRs are statistically significant at the 95% level.
†In terms of optimal level of relevant vitamin (column 2).
‡Epidemiological study.
§Placebo-controlled, intervention study.
Superscript numerals refer to the article in the list of references.
**Coronary heart disease for men[41] was defined as nonfatal AMI, fatal coronary disease, CABG, and PTCA. For women,[42] major coronary heart disease was defined as nonfatal AMI and fatal coronary heart disease.

Table 4.—*Projected Impact of Vitamin E Intake on Preventing U.S. Hospitalizations and Charges: Coronary Heart Disease*

Medical Condition	*Preventable Hospitalizations (thousands)*	*Preventable Hospital Charges ($ millions)*	*Preventable Charges (Expected Benefit) per capita*
CHD*			
Males	124–149	3,828–4,607	$57.7–69.5
Females	136–162	3,195–3,792	$58.9–70.0
Age 35–50	104–125	2,368–2,830	$40.1–48.0
Age over 50	156–186	4,655–5,569	$70.3–84.1
Medicare Enrollees	108–129	3,266–3,908	$92.8–111 per enrollee
Nonfatal Acute MI†			
Age under 62	178–192	4,732–5,085	$57.8–62.1
Age 62 and over	282–303	8,269–8,886	$214.6–230.6
Medicare Enrollees	244–263	7,730–8,314	$219.8–236.2 per enrollee

*From supplemental vitamin E intake of 30–400 IU/day. CHD incidence was defined as a discharge diagnosis of nonfatal AMI (ICD-9-CM 410), fatal coronary heart disease (ICD-9-CM 410–414), CABG (ICD-9-CM 36.1), PTCA (ICD-9-CM 36.01 or 36.02) for males and nonfatal AMI or fatal coronary disease for females.

†From supplemental vitamin E intake of 400–800 IU/day.

Preventable hospital charges are obtained on the basis of preventable fraction of hospitalizations for each condition (Table 4) and 1992 volume of hospital discharges and associated charges nationwide for corresponding conditions (reported in text).

defects were potentially preventable (Table 1) at an associated reduction of $1.6 billion in annual hospital charges and an expected per-pregnancy benefit of $247 (Table 2). Since not all cardiovascular birth defects are conotruncal defects, the estimated reduction in hospital charges is probably overestimated but excludes other related charges. These estimated savings are predicated on daily consumption of at least one serving of folic acid–fortified cereal; less frequent consumption had an insignificant impact on the risk of conotruncal cardiovascular birth defects.[34]

Low birth weight associated with preterm delivery. Several intervention trials,[19,38–40] as well as observational studies of women in prenatal care,[41,42] have estimated significant reduction in risk of LBW associated with intake of MVF+Z (containing 15–20 mg of zinc). Risk reduction estimates range from 18% (RR=0.82)[40] to 81% (RR=0.19).[39]

A recent observational study of women in prenatal care[42] showed that adjusted relative risk of LBW among women who consumed less than 0.24 mg of folic acid daily during the entire periconceptional period was 3.33 (1.82–6.09) times that of women who consumed more than 0.24 mg folic acid daily. The expected benefits of MVF supplementation are greater for pregnant black and adolescent women than for white adult women, more of whom take MVF supplements during the first trimester[31] and receive prenatal care.[36]

The most significant reduction in risk of LBW outcomes was associated with MVF during the first trimester of pregnancy.[42] As noted earlier, about 80.6% of American women receiving prenatal care consume multivitamin/mineral supplements.[31] Since only about 78% of all pregnant women obtain prenatal care during the first trimester,[36] we would expect that 62.9% (78% of 80.6%) of all pregnant women take multivitamins in the first trimester. Since 26% of all women consume multivitamins before conception, an additional 5.7% (26% of the 22% not in prenatal care) of pregnant women may be assumed to consume multivitamins. Thus, first-trimester multivitamin use is projected to equal 68.6% (62.9% + 5.7%), and PVAR equals 31.4% (100% – 68.6%). Therefore, between 6.7 and 58.8% of all LBW discharges are potentially preventable with daily use of MVF containing 15–20 mg of zinc during the first trimester of pregnancy (Table 1). The projected national impact of universal supplementation on annual hospital charges associated with LBW is a reduction of $173 million to $1.5 billion (Table 2).

Based on 1995 manufacturer's suggested retail prices for MVF (about $25 annually), the total annual cost of supplementation for all pregnant women is approximately $162 million. Thus, for most adverse birth outcomes, MVF supplementation has unambiguous net economic benefits from avoidable hospital charges alone (Table 2). Although that is not the case for NTD, it is clear that the enormous lifetime cost of NTD offsets the cost of supplements. Further, since MVF supplementation to the targeted female population is expected to reduce the risk of many other conditions at the same time, the aggregate preventable hospital charges are at least $1.3 billion (Table 2).

Coronary heart disease. Several studies have examined the association between supplemental vitamin E (a major lipid-soluble antioxidant) and CHD.[43–47] A study of male health professionals[44] found a 37% reduced risk of fatal coronary disease, nonfatal AMI, CABG, and PTCA, and of female health professionals,[45] a 41% reduced risk of nonfatal AMI and death from CHD. Both findings were conditional on vitamin E supplementation (at least 100 IU/day) for two or more years. The average intake of vitamin E from total dietary sources is less than 15 IU/day for men and less than 10 IU/day for women.[48,49] Very few foods are fortified with vitamin E; the few natural sources of vitamin E, such as almonds, vegetable oils, and wheat germ, contain relatively low concentrations per serving.[50] Surveys have reported that about 4% of the population use daily vitamin E supplements, which typically contain 200–400 IU, and that 23% use multivitamin supplements,[51,52] which typically contain 30 IU of vitamin E. Therefore about 27% of the U.S. population have vitamin E intake levels at or above the U.S. RDI of 30 IU/day. Assuming conservatively that only 73% of U.S. adults consume levels of vitamin E below that associated with reduced CVD risk, the preventable fraction of hospitalizations for these conditions equals 30% for men and 33.7% for women (Table 3).

About 4% of the adult population do take vitamin E supplements at optimal levels, however, making the PVAR for vitamin E 96%, and the preventable fraction of hospitalizations 36.1% for men and 40% for women (Table 3). In summary, daily vitamin E supplementation at 100 IU/day or more could cut $3.8–4.6 billion in annual hospital charges for men and $3.2–3.8 billion for women. Potentially, as much as $4.7–5.6 billion of annual U.S. hospital charges for all of these coronary outcomes could have been avoided if the 65.5 million Americans over age 50 in 1992 had consumed at least 100 IU of supplemental vitamin E daily (Table 4).

An alternative estimate of savings from CHD prevention was derived from a prospective, placebo-controlled, double-blind intervention study[46] that investigated the association between vitamin E supplementation at 400 IU or more per day and the RR of nonfatal AMIs in CHD patients with a mean age of 62 years. The study found an RR of 0.23 (0.11–0.47), or a risk reduction of 77%, in nonfatal AMIs associated with daily supplementation with vitamin E for 1.4 years. Projected effects are shown in Tables 3 and 4. If the aged Medicare population took 400 IU of vitamin E per day for 1.4 years, then approximately 250,000 nonfatal AMI hospitalizations potentially could be prevented each year (Table 4). At estimated 1995 retail prices ($67 for an annual supply), vitamin E supplementation over 1.4 years would have had a total cost of about $3.3 billion to Medicare, far less than the preventable hospital charges of $7.7–8.3 billion (Table 4).

Discussion

There have been only a few systematic analyses of potential costs and benefits of prevention, in particular primary prevention.[53–56] This study used the data in the scientific literature on risk reduction associated with vitamin supplementation to predict the potential reductions in annual hospitalizations and associated charges. The data indicate substantial cost reductions associated with vitamin supplement–based preventive nutrition. In all the cases examined, the micronutrients associated with improved outcomes (folic acid, zinc, vitamin E) are not present consistently in average diets at the levels associated with risk reduction.[50,57,58] Importantly, the highest dietary intake and concomitant use of supplements is associated with the greatest risk reduction.

Compared with other preventive interventions, vitamin supplementation appears to yield benefits relatively quickly. This is so for MVF supplementation in the periconceptional period to prevent adverse birth outcomes as well as for vitamin E–based cardiovascular disease prevention. From the perspective of health economics, the net economic benefit is positive for most vitamin interventions in terms of potentially avoidable hospital charges alone; total savings may be much greater.

Our study suggests that poverty is a critical factor in LBW, given the disproportionately higher risk among Medicaid births, consistent with previous evidence.[59,60] Other evidence shows a direct association between vitamin supplementation use and socioeconomic status.[31] Thus, our estimates of potential savings predict added benefits to expanding the Special Supplemental Food Program for Women, Infants, and Children[61] to include multivitamin supplementation for all women of childbearing potential rather than just women who are already pregnant. Our estimates can also be used to evaluate the relative cost-effectiveness of expansion of the federal food stamp program to include multivitamin supplements, which has been recommended elsewhere.[62] These analyses have also highlighted a major predicted savings of about $5 billion a year as a result of reduced CHD hospitalizations associated with vitamin E supplementation. Although hospital charges may overstate actual payments by insurers, this measure underestimates total potential savings since our calculations do not include physician fees, outpatient services, or prescriptions.

In addition to savings in direct medical costs, other benefits of avoided disease include increased productivity, improved longevity, and more quality-adjusted life-years.[63] Thus, the preventive nutrition strategies reviewed above can be evaluated not only in terms of reduced health care costs, but also in terms of mitigated human consequences of adverse pregnancy outcomes and serious coronary events. Finally, while we have evaluated benefits of nutritional supplements, a healthful diet must still be encouraged; however, in these specific examples it was not possible through diet alone to attain the levels of nutrients demonstrated to be beneficial.

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