THE USE OF CHROMIUM PICOLINATE AND ITS EFFECT ON THE RISK OF DIABETES-ATTRIBUTED CORONARY HEART DISEASE

The total health care expenditure on managing and treating diabetes-attributed CHD among diabetics over the age of 55 with CHD will be an average of $33 billion per year from 2013 to 2020.

Prevalence and Social Consequences

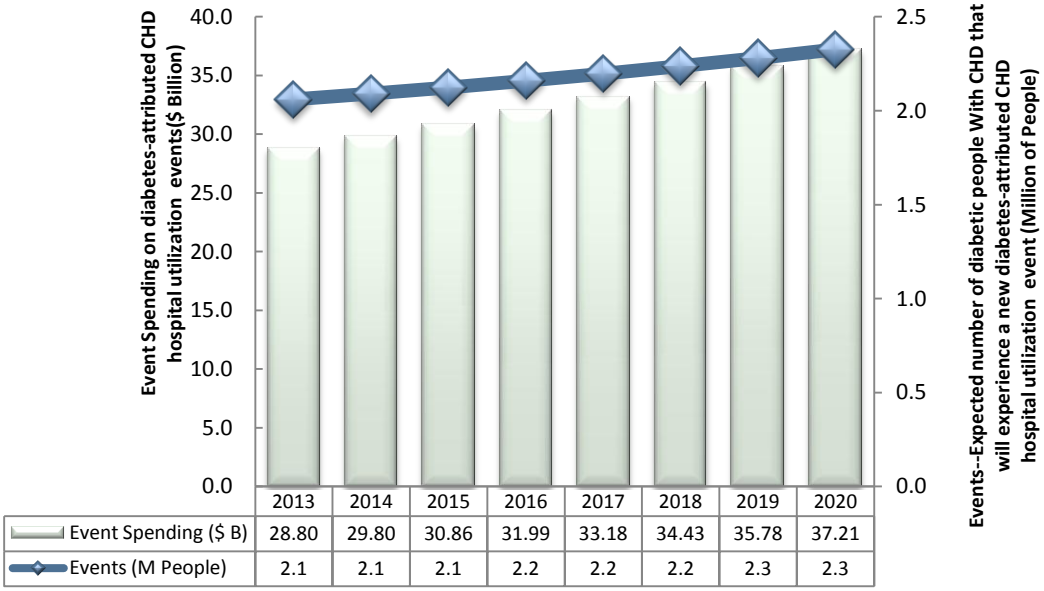
Type 2 diabetes mellitus (type 2 diabetes) is the most common form of diabetes in the United States; 90 to 95% of diabetes patients suffer from type 2 diabetes. The total health care cost of diabetes in 2012 in the United States was about $245 billion, of which $176 billion was attributed to direct medical costs and $69 billion in reduced productivity, according to the American Diabetes Association (American Diabetes Association, 2011). Regarding direct medical costs, nearly 60% of total expenditures are related to hospitalizations. Type 2 diabetes is a chronic disease marked by high levels of glucose in the blood. It is most common in patients that are over the age of 55, have a high-density lipoprotein (HDL) cholesterol of less than 35 mg/dL or triglyceride level of greater than 250 mg/dL, and/or have high blood pressure. The primary means to inhibit complications related to type 2 diabetes are diet and exercise. However, if diet and exercise do not help a person maintain normal glucose levels, physicians may have to prescribe medication.

In 2012, it was estimated that more than 17 million U.S. adults over the age of 55 suffered from diabetes (American Diabetes Association, 2011). Men are slightly more likely to have diabetes than women, and non-Hispanic blacks have higher prevalence rates compared with non-Hispanic whites, Asian Americans, and Hispanics. Within this group, nearly 7 million adults over the age of 55 have also been diagnosed with CHD, and nearly 2 million of these people suffer from a CHD event annually[23]. This suggests that total expenditures on direct medical costs associated with diabetes-attributed CHD events were $26.4 billion in 2012.

23 Based on the Frost & Sullivan analysis of the National Health and Nutrition Examination Survey (National Health and Nutrition Examination Survey, 2010)

The total cumulative direct health care costs related to diabetes-attributed CHD events is expected to be over $260 billion from 2013 to 2020 among all diabetics over the age of 55 diagnosed with CHD.

Figure 5.1—Total Expenditure Forecast of Diabetes-attributed CHD Events among All Diabetic Adults over the Age of 55 with CHD, 2013–2020



	2013	2014	2015	2016	2017	2018	2019	2020
Event Spending ($ B)	28.80	29.80	30.86	31.99	33.18	34.43	35.78	37.21
Events (M People)	2.1	2.1	2.1	2.2	2.2	2.2	2.3	2.3

Note: All figures are rounded. Source: Frost & Sullivan analysis.

Projecting these per-person expenditures forward at an average compound annual growth rate of 5% from 2013 to 2020 and assuming an average compound annual target population growth rate of 1.7% during the same period, it is expected that an average of 2.2 million diabetic adults over the age of 55 and diagnosed with CHD will experience a costly CHD event, defined as all inpatient hospitalizations and emergency room visits from 2013 to 2020, at an annual average cost of $16,690 per person (Agency for Healthcare Research and Quality—MEPS). This implies that the total cumulative direct health care costs related to CHD events among all U.S. adults over the age of 55 diagnosed with CHD will be more than $262.05 billion over the forecast period; additionally, the annual average direct health care costs related to CHD events among this target population will be nearly $33 billion per year.

Multiple studies suggest that the use of chromium picolinate dietary supplements has a substantiated preventive effect on diabetes-attributed CHD events, which will be explored in detail in this chapter.

Figure 5.2—Diabetes-attributed CHD events Cost Summary for All Diabetic Adults over the Age of 55 Diagnosed with CHD, 2012–2020

Metric	Measure
Population of adults over the age of 55 diagnosed with type 2 diabetes, 2012	17,021,840
Population of type 2 diabetics with CHD, 2012 (People high-risk of experiencing an event)[24]	6,973,705
Population of type 2 diabetics with CHD who experienced a diabetes-attributed CHD-related inpatient procedure and/or visited the emergency room, 2012	1,980,116
Event rate—percent of the high-risk population that will experience a CHD event, (ER)	12%
Diabetes-attributed CHD hospital utilization event spending (inpatient procedures and emergency room visits), 2012[25]	$26.37 B
Expected average annual diabetes-attributed CHD hospital utilization event spending (inpatient procedures and emergency room visits), 2013–2020	$32.76 B
Cumulative diabetes-attributed CHD hospital utilization event spending (inpatient procedures and emergency room visits), 2013–2020	$262.06 B
Average claimed expenditures per person per year, 2012	$13,317
Expected average claimed expenditures per person per year, 2013–2020	$16,690

Source: Summary Health Statistics for U.S. Adults: National Health Interview Survey 2011—Centers for Disease Control and Prevention, Center for Financing, Access and Cost Trends—Agency for Healthcare Research and Quality; Medical Expenditure Panel Survey, 2010 and Frost & Sullivan

The biochemical mechanism of chromium on diabetes may be related to chromium's interaction with insulin receptors on cell surfaces.

Chromium picolinate

Literature Review

The form of chromium found in food and supplements is trivalent chromium, which is an essential trace mineral in human nutrition (Memorial Sloan-Kettering Cancer Center, 2013). Chromium is essential to insulin action in the metabolism of glucose (Memorial Sloan-Kettering Cancer Center, 2013). The biochemical mechanism of chromium is under study but may be related to chromium's interaction with insulin receptors on cell surfaces (Memorial Sloan-Kettering Cancer Center, 2013). Among the many dietary sources of chromium are meat, eggs, whole grains, broccoli, and beans (Memorial Sloan-Kettering Cancer Center, 2013). Of the forms of chromium for dietary supplementation, the picolinate form is more common because of its higher bioavailability.

The IOM has established adequate intake levels for chromium of 20 mcg per day for women over 50 and 30 mcg per day for men over 50 (Office of Dietary Supplements, 2005). There is insufficient data to establish a LOAEL, NOAEL or UL for trivalent chromium because "[n]o adverse effects have been convincingly associated with excess intake of chromium from food or supplements, but this does not mean that there is no potential for adverse effects resulting from high intakes" (Institute of Medicine, 2001).

24 Includes all diabetes-attributed events such as angina pectoris, heart attack, or any other heart condition or disease events.

25 An event is defined as any claimed treatment or disease management activity that requires expenditure to be paid out-of-pocket, by private insurance companies, or by Medicare or Medicaid and includes all hospital outpatient or office-based provider visits, hospital inpatient stays, and emergency room visits.

Because of its role in insulin action, many studies have been undertaken to investigate possible benefits of chromium supplementation on subjects with diabetes, particularly type 2 diabetes. To quantify the possible effects of chromium supplementation on the occurrence of diabetes-related CHD events, a systematic search was conducted that focused on published studies of chromium supplementation on glycated hemoglobin (HbA1c) levels in diabetes. HbA1c is a common measure of glycemic control in diabetes, and it is also correlated with the rate of CHD. Ray et al., (2009) estimated from a systematic review of five RCTs involving more than 33,000 subjects undergoing intensive glucose-lowering regimens that a 0.9% reduction in HbA1c concentration correlates with a 15% reduction in CHD events (Ray, et al., 2009). This correlation was assumed to hold for the purposes of this study in order to model health care savings because of improved glycemic control from chromium supplementation. In addition, because of this substantiated direct link between improved glycemic control and a reduction in the risk of a CHD event among those who have type 2 diabetes, the focus of the cost model explored the direct effect of intensive chromium picolinate supplementation on direct medical costs related to only CHD events.

A PubMed literature search was conducted to identify a set of studies that represented the purported link between chromium supplementation and CHD risk. Only studies that tested for a causal relationship between supplement intake and the level of HbA1c were identified. Only studies similar in protocol in an attempt to control for observable variance were included in the analysis. Studies were not selected on the basis of the magnitude, direction or statistical significance of the reported findings. A total of 30 studies matching keyword combinations such as “chromium picolinate”; “diabetes” and/or “coronary heart disease”; and “risk reduction” were identified in the rigorous search. Of the reported study methods, randomized controlled trials (including crossover studies) were preferred because they are designed to directly test for a cause-and-effect relationship between chromium picolinate supplementation and the desired HbA1c reduction outcome. The search was conducted between February 1 and March 31, 2013.

Four RCT studies were identified as being representative of the indirect relationship between dietary supplement intake and the risk of a CHD-attributed disease event through the HbA1c biomarker. All four studies included subjects who had been diagnosed with type 2 diabetes. The studies compared a treatment group that received a daily chromium picolinate supplement regimen versus a placebo group. In the single crossover study, subjects took either chromium or placebo for a period, followed by a washout period, and then switched to the opposite product. Chromium supplementation was given for between three weeks and six months, depending on the study.

Figure 5.3—Chromium Picolinate Literature Review: Description of the Qualified Studies—Summary of Findings

Author	Year	Study details	Total sample (N)	Net percentage point change in HbA1c among treatment group versus control due to intensive chromium picolinate supplementation (%)
Albarracin	2008	RCT - Type 2 diabetic subjects; change in HbA1c with Cr vs. placebo is significantly different. Dose size was 600 mcg.	348	0.20
Anderson	1997	RCT - Type 2 diabetics. Dose size was 1000 mcg.	120	2.10
Ghosh	2002	Crossover Design - Type 2 diabetics in India. Dose size was 400 mcg.	50	0.70
Rabinovitz	2011	RCT - Elderly type 2 diabetics in Israel. Dose size was 400 mcg.	78	0.60
Sample Size Weighted Average				0.83
Reduction in the Relative Risk of a CHD Event for a .9 Percentage Point Decrease in HbA1c Levels (%)				15.0%[26]
Reduction in the Relative Risk of a CHD Event Given Intensive Chromium Picolinate Supplementation (%)				10.2%

Note: All figures are rounded. Source: Frost & Sullivan

Albarracin (2008) studied 447 U.S. overweight type 2 diabetics (Albarracin, Fuqua, Evans, & Goldfine, 2008). The treatment patients received a chromium supplement (600 mcg/day as picolinate) along with biotin, while the placebo group received neither. Biotin, a B vitamin, was included because it may also play a role in carbohydrate metabolism. After 90 days of supplementation, the chromium group showed a decrease in HbA1c of 0.54%, which was significantly different from the decrease of 0.34% in the control group. Anderson (1997) studied 180 type 2 diabetics in the U.S. The treatment group received 1000 mcg per day of chromium picolinate (Anderson, et al., 1997). After four months, the HbA1c levels in the treatment group averaged 6.6%, compared to 8.5% in the placebo group. Ghosh et al., (2002) studied 50 type 2 diabetics in India in a randomized, crossover trial lasting 12 weeks per treatment (Ghosh, et al., 2002). Chromium was supplemented as picolinate at 400 mcg/day. After chromium supplementation, the average HbA1c levels remained unchanged; however, they increased significantly in the placebo group by 0.7%, revealing a net benefit of chromium.

Finally, Rabinovitz et al., studied 78 diabetics of average age 78 years in Israel. Half received 400 mcg of chromium picolinate daily as well as standard treatment for diabetes, while the control half received standard treatment but no chromium supplement. After three weeks the HbA1c levels of the treatment group declined by 0.6%.

26 Ray, et al., 2009

An average of 81,243 CHD events could potentially be avoided annually from 2013-2020 if all diabetics over the age of 55 diagnosed with CHD were to use chromium picolinate dietary supplements at protective levels of intake. This amounts to 649,944 avoided events over the entire period.

Empirical Results

Given the literature review of the key qualified studies, it is estimated that the calculated relative risk reduction of a diabetes-attributed CHD event among patients over the age of 55 who have been diagnosed with CHD and given chromium picolinate dietary supplements at preventive daily intake levels was 10.2%. This estimate was deduced after controlling for variance due to sample size, research methodologies and study protocols, and patient population differences within each study and among all studies.

Figure 5.4—Chromium Picolinate Literature Review: Summary Results—CEBM Approach

Metric	Measure
Weighted relative risk reduction (weighted for inter-study variance) (RRR)	10.2%
Event rate (ER)	12%
Number of people needed to treat to avoid one diabetic-attributed CHD event (NNT), people	95
Average number of events CHD avoided annually if everybody in the target population* used chromium picolinate, 2013–2020	81,243
Cumulative number of events CHD avoided if everybody in the target population* used chromium picolinate, 2013– 2020	649,944

* Among all diabetic adults over the age of 55 with CHD
Note: All figures are rounded. Source: Frost & Sullivan

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Using the CEBM approach (Center for Evidence Based Medicine, 2012) to calculate NNT, 95 people would have to be treated with an intensive regimen of chromium picolinate supplements (over 400 mcg per day) to avoid one diabetes-attributed CHD event. This calculation takes into account the 12% odds of a diagnosed diabetic person over the age of 55 experiencing a CHD event during a year. Given the NNT of 95 people, which is achievable if every high-risk person in the target population were to take at least 400 mcg of chromium picolinate daily, avoided hospital utilization expenditures related to diabetes-attributed CHD events would average $1.2 billion per year—a cumulative savings of $9.75 billion from 2013 to 2020, assuming an annual average cost per person experiencing a CHD-related event of $16,690. This equates to an annual average of 81,243 avoided events from 2013 to 2020—649,944 cumulative avoided events.

For the purposes of this study, a daily dosage was assumed to be equal to or more than 400 mcg per day. Based on the review of qualified scientific literature, researchers treated their respective groups with intensive regimens of chromium picolinate on the order of 400 to 1000 mcg per day. Based on a review of chromium dietary supplement products on the retail market, the majority of such products contain at least 400 mcg of chromium picolinate per serving. Thus, it was determined that the cost of a daily dose of an intensive regimen of chromium picolinate ranges from $0.03 to $0.18. The median daily cost to the consumer is $0.09. Using this figure, the expected annual supplementation cost would average $248.7 million per year for the total target population—nearly $2.0 billion from 2013 to 2020.

Thus, the net savings, after accounting for the cost of chromium picolinate dietary supplementation, would average $970.0 million per year—nearly $7.80 billion cumulatively from 2013 to 2020. See Figures 8.17 to 8.20 in the appendix for a detailed reporting of the empirical results.

An average of $1.22 billion per year and a cumulative savings of $9.75 billion from 2013 to 2020 in avoidable hospital utilization costs is potentially realizable if all diabetics over the age of 55 diagnosed with CHD were to use chromium picolinate dietary supplements at preventive daily intake levels.

Figure 5.5—Chromium Picolinate Cost Analysis: Summary Results—Cost of Dietary Supplementation of the Target Population*, 2013–2020

Metric	Measure
Median daily cost of chromium picolinate supplementation at protective intake levels, 2013	$0.09
Expected annual median cost of chromium picolinate supplementation at protective intake levels, 2013	$34.67
Average annual cost of chromium picolinate dietary supplementation of the target population*, 2013–2020	$248.7 M
Cumulative cost of chromium picolinate dietary supplementation of the target population*, 2013–2020	$1.99 B

* Among all diabetic adults over the age of 55 with CHD
Note: All figures are rounded. Source: Frost & Sullivan

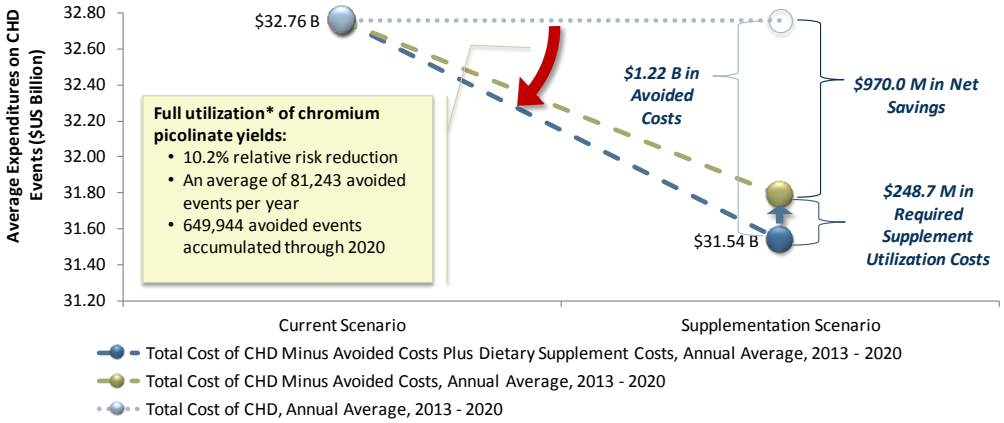
Figure 5.6—Chromium Picolinate Cost Analysis: Summary Results—Avoided Hospital Utilization Expenditures* due to Dietary Supplement Intervention, 2013–2020

Metric	Measure
Average annual avoided hospital utilization expenditures related to CHD if incidence is reduced through the use of chromium picolinate supplements, 2013–2020	$1.22 B
Cumulative avoided hospital utilization expenditures related to CHD if incidence is reduced through the use of chromium picolinate supplements, 2013–2020	$9.75 B
Average annual hospital utilization expenditures for CHD-related events among the target population* if incidence is reduced through the use of chromium picolinate supplements, 2013–2020	$31.54 B
Cumulative hospital utilization expenditures for CHD-related events among the target population* if incidence is reduced through the use of chromium picolinate supplements, 2013–2020	$252.30 B

* Among all diabetic adults over the age of 55 with CHD
Note: All figures are rounded. Source: Frost & Sullivan

Over $7.75 billion in cumulative net CHD-attributed cost savings from 2013 to 2020 is potentially realizable if the entire target population were to use chromium picolinate dietary supplements at protective intake levels.

Figure 5.7—Chromium Picolinate Cost Analysis: Net Health Care Cost Savings* Summary Results, 2013–2020



* Among all diabetic adults over the age of 55 with CHD
Note: All figures are rounded. Source: Frost & Sullivan

Figure 5.8—Chromium Picolinate Cost Analysis: Summary Results—Net Cost Savings* due to Avoided Hospital Utilization Expenditures through Dietary Supplement Intervention, 2013–2020

Metric	Measure
Average net potential direct savings per year from avoided CHD hospital utilization events due to chromium picolinate supplement intervention, 2013–2020	$970.0 M
Cumulative net potential direct savings from avoided CHD hospital utilization events due to chromium picolinate dietary supplement intervention, 2013–2020	$7.76 B
Net benefit cost ratio, $ per one dollar spent on dietary supplement	$3.90

* Among all diabetic adults over the age of 55 with CHD
Note: All figures are rounded. Source: Frost & Sullivan

Conclusion

The chromium picolinate cost-benefit analysis assumes that in the supplementation scenario all diabetic adults over the age of 55 with CHD use chromium picolinate at protective intake levels from a base of zero usage among this population segment. In other words, the calculated net savings is the total potential net savings that are realizable. However, because it is likely that less than 1% of diabetic adults over the age of 55 are regular users of chromium picolinate dietary supplements because of the low awareness of its health benefits, nearly all of the $970.0 million in potential net savings has yet to be realized. Thus, it is expected that there are significant cost savings yet be realized through the increased usage of chromium picolinate dietary supplements among the high-risk target population.

It is expected that less than 1% of adults over the age of 55 are already regular users of chromium picolinate dietary supplements, suggesting that nearly all of the potential net cost health care savings have yet to be realized.

Overall, the scientific evidence suggests that the use of chromium picolinate helps to lower HbA1c levels; thus, the potential health care cost savings derived from its use is expected to be significant. Specifically, if one were to only look at the potential avoided costs of diabetes-attributed CHD events among diabetics over the age of 55 with diagnosed CHD, the total cost savings derived from avoided CHD events would average $970.0 million per year—nearly $7.80 billion cumulatively over the forecast period—after accounting for the cost of chromium picolinate dietary supplementation. This equates to a significant $3.90 that can be saved per $1 spent on chromium picolinate, in terms of the ratio of avoided CHD-related costs because of supplementation per $1 spent on the supplements. This is primarily because chromium picolinate is shown to be essential to insulin action in the metabolism of glucose, and its overall cost to consumers is low.

Based on the findings of this study, chromium picolinate is suggested to be a key component maintenance regimen for type 2 diabetics at high risk of suffering a CHD event; however, more scientific research should be undertaken to test this hypothesis to avoid the use of indirect means to calculate treatment numbers needed to avoid one CHD event. In addition, the inability to effectively metabolize glucose leads to other potential problems, including vision disabilities, feet and renal problems, and general mobility issues, all of which add to the total cost of diabetes. The true potential cost savings could be significantly greater than what is presented in this case study, which confirms the need for more scientific research that tests the direct link between lower HbA1c levels and lower diabetes-attributed CHD events to further substantiate the importance of chromium picolinate's role in helping to control growth in societal health care costs.