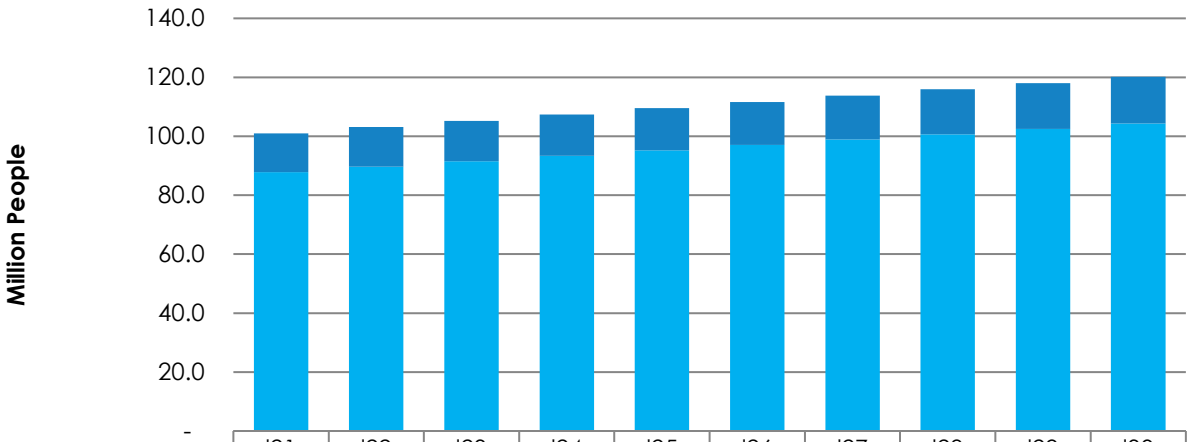
THE COST EFFECTIVENESS OF OMEGA-3, MAGNESIUM, SOLUBLE FIBER, AND VITAMIN K2 DIETARY SUPPLEMENTATION FOR MANAGING THE RISK OF CORONARY ARTERY DISEASE OUTCOMES

The Burden and Social Consequences

Coronary artery disease (CAD), also known as coronary heart disease (CHD) or ischemic heart disease (IHD), is caused by the buildup of plaque on arterial walls [6]. The plaque, being composed of cholesterol and other substances, causes the inside of arteries to narrow over time which in turn can cause blockages to occur and lead to heart attacks and heart failure.

CAD puts a heavy burden, both financially and in terms of reduced quality of life, on U.S. citizens, and Americans are increasingly struggling to cope with it, as well as the increasing costs of treating this disease condition. CAD continues to be the leading cause of death in the United States, ending 659,000 lives each year and accounting for 1 out of 4 deaths, according to the Centers for Disease Control and Prevention (CDC) [7]. According to the U.S. Department of Health & Human Services Agency for Healthcare Research and Quality, it is expected that 13.4 million U.S. adults aged 55 and older had experienced a CAD-attributed inpatient medical service or emergency room visit event in 2022, an event risk of 13.0% given a total population of 103.1 million Americans aged 55 and older [9].

Chart 1. Target Population Size of Coronary Artery Disease, United States, 2020-2030



	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
CAD Population	13.1	13.4	13.7	14.0	14.3	14.6	14.9	15.2	15.5	15.8
Heathy Adults	87.8	89.7	91.5	93.4	95.2	97.0	98.9	100.7	102.5	104.4
All Adults	101.0	103.1	105.2	107.4	109.5	111.7	113.8	115.9	118.1	120.2

Source: Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Table 1. Target Population Size of Coronary Artery Disease, United States, 2020-2030

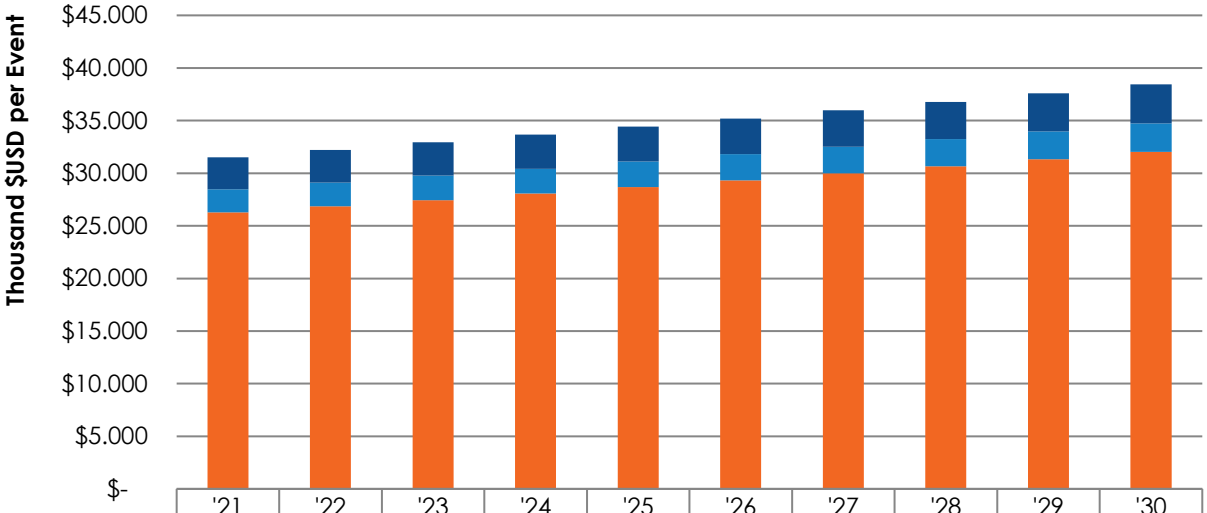
Year	Total Population, age 55 and older (million people)	Population of people experiencing CAD-attributed inpatient medical service or emergency room visits event, age 55 and older (million people)
2021	100.97	13.12
2022	103.11	13.43
2023	105.25	13.73
2024	107.38	14.03
2025	109.52	14.33
2026	111.66	14.63
2027	113.80	14.93
2028	115.93	15.23
2029	118.07	15.54
2030	120.21	15.84
Average ('22-'30)	111.66	14.63
CAGR	2.0%	2.0%

Source: Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Though the degree of effect varies, every CAD-attributed medical event entails financial burdens, including direct medical costs such as the costs of emergency room visits, hospitalization, surgery, medication, rehabilitation, and other costs tied to treating a medical event as well as indirect costs related to post-event disease management and the consequences of disability (e.g., lost wages and productivity losses). Based on a review of the Medical Expenditure Panel Survey (MEPS) database and Frost & Sullivan's analysis, the total expected direct medical expenditures on all CAD-attributed medical events for all U.S. adults aged 55 exceeded $413.6 billion in 2021 [9]. This is based on a mean per person expenditure on CAD-related inpatient procedures and emergency room visits plus the added monetary losses attributed to productivity which is expected to have equaled $31,517 in 2021. It should be noted that the financial burden per capita highly varies and depends on the severity of the event. Many CAD-attributed medical procedures cost more than the reported average and productivity losses can be much greater, especially for the younger individuals within the target population.

Given an expected compound annual population growth rate of 2.0% and an average inflation rate of 2.7% during the forecast period of 2022 to 2030, it is expected that the total expected direct medical expenditures on all CAD-related events for all U.S. adults aged 55 and older will exceed $608.9 billion by 2030. This equates to a mean per person expenditure on CAD-related inpatient procedures and emergency room visits of $38,455 in 2030, given an expected population of 120 million Americans aged 55 and older with CAD.

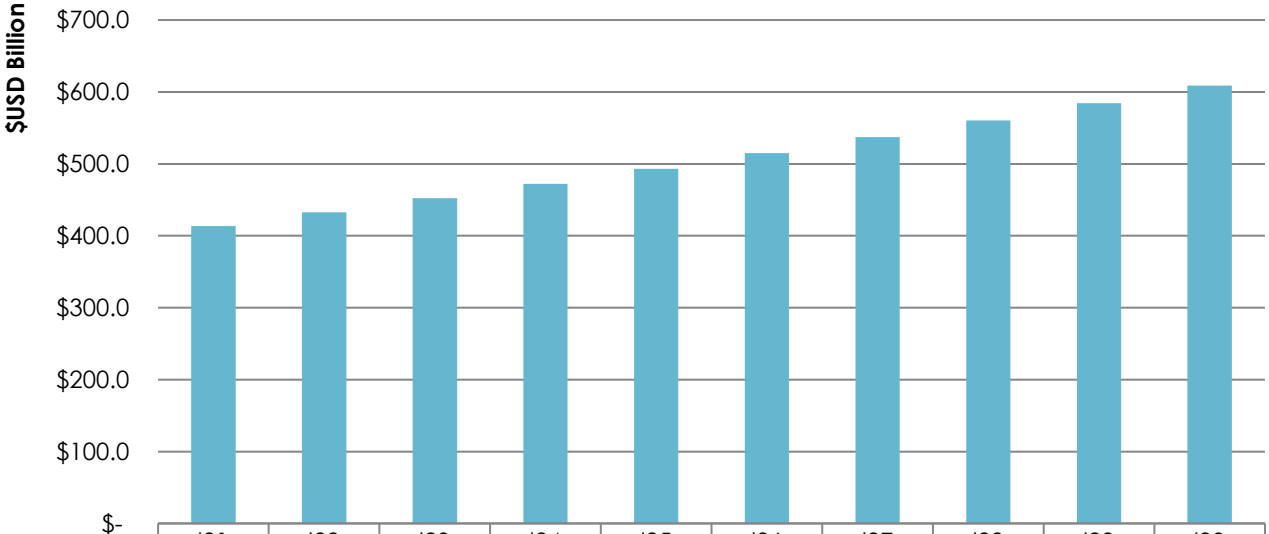
Chart 2. Average Health Care Losses and Productivity Losses per Coronary Artery Disease Event, Thousand $USD per Event, United States, 2020-2030



	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
Productivity	$3.04	$3.11	$3.18	$3.25	$3.32	$3.39	$3.47	$3.55	$3.63	$3.71
Pharma	$2.21	$2.26	$2.31	$2.37	$2.42	$2.47	$2.53	$2.58	$2.64	$2.70
Medical	$26.26	$26.85	$27.45	$28.06	$28.69	$29.33	$29.98	$30.65	$31.34	$32.04
Total	$31.52	$32.22	$32.94	$33.68	$34.43	$35.20	$35.98	$36.78	$37.61	$38.45

Source: Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Chart 3. Total Population Health Care Losses and Productivity Losses Attributed to Coronary Artery Disease, $USD Billion, United States, 2020-2030



	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
Total	$413.63	$432.58	$452.17	$472.41	$493.34	$514.96	$537.30	$560.38	$584.23	$608.86

Source: Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Table 2. Population Health Care Losses and Productivity Losses Attributed to Coronary Artery Disease, $USD Billion, United States, 2020-2030

Year	CAD, Cost of Medical ($ per Event Case)	CAD, Cost of Pharma ($ per Event Case)	CAD, Loss in Productivity ($ per Event Case)	CAD, Cost per Event Case ($ per Event Case)	CAD, Total Population Cost ($ billion)
2021	$26,265	$2,214	$3,038	$31,517	$413.63
2022	$26,851	$2,263	$3,106	$32,220	$432.58
2023	$27,450	$2,314	$3,176	$32,940	$452.17
2024	$28,063	$2,365	$3,246	$33,675	$472.41
2025	$28,690	$2,418	$3,319	$34,427	$493.34
2026	$29,330	$2,472	$3,393	$35,195	$514.96
2027	$29,985	$2,527	$3,469	$35,981	$537.30
2028	$30,654	$2,584	$3,546	$36,784	$560.38
2029	$31,339	$2,642	$3,625	$37,606	$584.23
2030	$32,038	$2,701	$3,706	$38,445	$608.86
Average ('22-'30)	$29,378	$2,476	$3,399	$35,253	$517.36
CAGR	2.2%	2.2%	2.2%	2.2%	4.0%
Cumulative ('22-'30)	--	--	--	--	$4,656.22

Source: Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Preventive approaches are critical to the reduction in demand for disease management services. One way to control the burden of CAD costs is to minimize the number of serious events in a target at-risk population. A CAD event may be preventable at least in part, or its seriousness may be meaningfully reduced, by individual patient choices because the development of the disease is believed to be largely a result of lifestyle choices. There is scientific consensus that high blood pressure, high LDL cholesterol, and smoking are leading risk determinants for CAD. High blood pressure and high LDL cholesterol are influenced by lifestyle choices including poor diet, physical inactivity, and alcohol use [7]. On the other hand, choices that have been shown to help to minimize CAD-related events are also available to each patient. Beneficial changes in diet are an example of a step an at-risk individual could take to potentially reduce their chances of experiencing a costly event. Moreover, there is increasing amount of evidence that certain key dietary supplements may reduce a person's odds of experiencing a CAD event.

In the following sections, it will be shown that the use of specific nutritiously dense dietary supplement products have been reported to have positive effects on the cardiovascular health of their users. This may also result in economic benefits in avoided medical costs. Specifically, this chapter explores the possible health and economic effects that could be derived from using four different dietary supplement regimens including omega-3 fatty acids, magnesium, soluble fiber, and

vitamin K2. For each of the four supplements presented here, a description of the scientific literature assessing each supplement's efficacy will be provided as well as projected implications for US healthcare stakeholders in the number of events potentially avoidable with the use of each supplement and economic benefits that could accrue from use of each supplement by an at-risk individual.

Table 3. Coronary Artery Disease Cost Summary Statistics for All U.S. Adults Aged 55 and over, 2021–2030

Metric	'21	CAGR ('21 - '30)	Average ('22 - '30)	Cumulative ('22 - '30)
Total Population, million people	100.97 M	1.96%	111.66 M	--
Population with CAD (people at high risk of experiencing an event), million people	13.12 M	2.11%	14.63 M	--
Event rate—percent of the high-risk population diagnosed with CAD, %	13.0%	0.15%	13.1%	--
Direct cost of CAD, medical service utilization, $USD per Case	$26,265	2.23%	$29,378	--
Direct cost of CAD, pharmaceutical utilization, $USD per Case	$2,214	2.23%	$2,476	--
Indirect Cost of CAD, productivity losses, $USD per Case	$3,038	2.23%	$3,399	--
Total cost of CAD, $USD per Case	$31,517	2.23%	$35,253	--
Total target population cost of CAD, $USD billion	$413.63 B	4.39%	$517.36 B	$4,656.22 B
Price inflation rate, %	6.95%	--	2.23%	

Source: Centers for Disease Control and Prevention, Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey (MEPS)., US Census, and Frost & Sullivan analysis

Vitamin K2

Literature Review

Vitamin K is a fat-soluble vitamin found naturally in green leafy vegetables, fermented foods, and animal products and the nutrient plays a vital role in blood clotting, bone metabolism, and regulating blood calcium levels [10]. Specifically, Vitamin K is essential for the synthesis of proteins belonging to the γ-carboxyglutamic acid (Gla) protein family. Gla proteins formed in the liver, such as II (prothrombin), VII, IX, and X, play a vital role as procoagulants in hemostasis and prevent bleeding [28]. Other Gla proteins synthesized in the liver, such as Protein C, S, and Z, act as anticoagulants in hemostasis, which inhibits blood clotting. Gla proteins synthesized in tissues include osteocalcin, matrix Gla protein (MGP), and growth-arrest sequence 6 protein (Gas6), which play key functions in maintaining bone strength, arterial calcification inhibition, and cell growth regulation, respectively.

Vitamin K2, also called menaquinones, is a type of vitamin K and is a group of compounds with unsaturated side chains of varying length (chain lengths of 4 to 13 isoprenyl units) [28]. Menaquinone-4 (MK-4), also called menatetrenone, is a short chain vitamin K2 found in animal products such as meat, cheese, and eggs [28]. Longer chain menaquinones such as MK-7, MK-8, MK-9 or higher are found in fermented foods such as cheese, curd, and sauerkraut. MK-7 is found in exceptionally high concentrations in the traditional Japanese food natto [28].

Vitamin K2's role in maintaining health is multifaceted and a growing area of research. Apart from higher bioavailability, several clinical studies show how vitamin K2 serves to improve bone and cardiovascular health. Specifically, it is known that vitamin K2 has a role in both minimizing coronary artery calcium accumulation and increasing calcium content in bone. Specifically, vitamin K2 helps our bodies better distribute and regulate calcium and thus has both heart health and bone health benefits [29]. In other words, vitamin K2 has the potential to both lower the risk of CAD events and minimize the development of osteoporosis, and thus minimize the risk of bone fractures later in life.

To infer the expected efficacy of using vitamin K2 on the occurrence of a CAD event, a literature review was conducted in March 2022 that focused on published studies that tested for and quantified the effect of vitamin K2 supplementation on the incidence of CAD-related medical events requiring medical treatment. The goal of this study was to collect a sample of studies that represented the state of all scientific literature on vitamin K2 supplementation. In addition, studies selected for analysis must have tested for a direct causal relationship between the intake of a vitamin K2 dietary supplement regimen and the relative risk of a CAD event. It was preferred that the selected studies were similar in study protocol in an attempt to control likely variances, though this is not always possible due to the nature of it being a young body of research. Specifically, of the various study methods found for vitamin K2 supplementation, randomized controlled trials (RCT)

were preferred because they are designed to directly test for a cause-and-effect relationship between treatment and outcome though prospective cohort studies were also considered because they too tested for similar and comparable hypotheses. Studies were not selected on the basis of the magnitude, direction, or statistical significance of the reported findings.

One hundred twenty-six (126) studies were found in a PubMed search based on the use of "vitamin K2" or "menaquinone" or "; "coronary heart disease" or "coronary artery disease"; and "risk reduction" as filtering keywords. The search was conducted between March 1 and March 31, 2022. Once the set of possible studies were created, each study's title, abstract and results was thoroughly reviewed and assessed to determine whether there was an association between supplement intake and the relative risk or odds ratio of a coronary artery disease event. Specifically, a study was considered qualified for inclusion in the analysis if it tested for a relationship between the intake of a vitamin K2 supplement and the reduction in the odds of a CAD event occurring, independent of the direction of the relationship. Six (6) prospective cohort studies were identified as representative of the vitamin K2 literature and were used to deduce the estimated efficacy of high intake of K2 on reducing CAD-related medical event risk. It should be noted that that there were no RCTs identified that directly assessed the vitamin K2 intervention and CAD events and the relative risk estimated for the cost analysis is based on observational studies. However, a number of RCTs were uncovered that showed a link between vitamin K2 supplement intake and vascular biomarkers [206, 207]. Table 25 shows a description of a selection of included studies in the final meta-analysis.

Researchers began to get a better understanding of the potential benefits of using vitamin K2 menaquinone in 2004 when researchers from the Rotterdam Study first uncovered a possible association with its intake and a reduced risk of experiencing a coronary heart disease event [31]. The researchers used data from the Rotterdam Study which included 4,807 patient subjects as of 1990 to 1993 and who were followed for 7 to 10 years [31]. After assessment using a Cox regression model to derive relative risk, it was found that the relative risk of a coronary heart disease event among the top tertile of subjects was 41% lower compared to the lowest tertile (Relative Risk = 0.59, 95% CI: 0.40-0.86) after controlling traditional risk factors and food intake considerations [31].

Table 25. Vitamin K2 Literature Review: Description of the Qualified Studies

Refe-rence	Author	Year	Daily dose and Study Duration	Event definition
31	Geleijnse *et al.*	2004	More than 32.7 micrograms per day versus less than 21.6 micrograms per day. Patients were followed for 7 to 10 years.	Incident CAD Events
30	Gast *et al.*	2009	More than 36 micrograms per day versus less than 21.6 micrograms per day. Patients were followed for 8.1 +/- 1.6 years.	Hazard Ratio of Experiencing a CAD Event between the High Intake versus Low Intake quartile cohorts
153	Juanola-Falgarona *et al.*	2014	More than 57.5 micrograms per day versus less than 18.4 micrograms per day. Patients were followed for an average of 4.8 years.	Hazard Ratio of Experiencing a CAD Death between the High Intake versus Low Intake quartile cohorts
34	Zwakenberg *et al.*	2017	63.7 ± 11.3 micrograms per day versus 26.2 ± 4.9 micrograms per day. Patients were followed for an average of 16.8 years.	Hazard Ratio of Experiencing a CAD Death between the High Intake versus Low Intake quartile cohorts
32	Haugsgjerd *et al.*	2020	More than 15 (11 to 21) micrograms per day versus less than 24 (21 to 29) micrograms per day. Patients were followed for an average of 11 years.	Hazard Ratio of Experiencing a CAD Event between the High Intake versus Low Intake quartile cohorts
33	Bellinge *et al.*	2021	More than 77 (65 to 296) micrograms per day versus less than 23 (0 to 29) micrograms per day. Patients were followed for an average of 21 years.	Hazard Ratio of Experiencing ASCVD-related hospitalization between the High Intake versus Low Intake quintile cohorts

In 2009, Gast et al. were one of the earliest team of researchers to discover a strong association between high vitamin K2 intake and lower risk of experiencing a coronary heart event [30]. Using data from the Prospect–EPIC cohort study which included 16,057 women free of heart disease age 49 to 70 years old, the researchers followed the cohort for a mean 8.1 years and the researchers counted 480 cases of CHD during that time [30]. At the time, the mean vitamin K2 intake level among the cohort was only 29.1 micrograms per day per person, which is significantly lower than generally recommended today [30]. The researchers used a multivariate Cox proportional hazards model to estimate the hazard ratios and found that the relative risk of experiencing a CAD-event was negatively correlated with vitamin K2 intake after controlling for other traditional risk and dietary factors (Hazard Ratio = 0.91, 95% CI: 0.85-1.00) [30].

Additionally, a prospective cohort study that included 33,289 participants aged 20-70 years was published by Clinical Nutrition in 2017 and showed that high intake of vitamin K2 was correlated with a significant reduction in the risk of CAD (coronary heart disease) [34]. Specifically, those individuals within the high vitamin K2 intake cohort had significantly lower odds of experiencing a CAD-attributed mortality event compared to the low vitamin K2 intake cohort (Hazard Ratio = 0.86, 95% CI: 0.74-1.00) [34].

In 2021, researchers evaluated the resultant relative risk of experiencing an atherosclerotic cardiovascular disease event (hospitalization) given relative vitamin K2 intake levels among 53,372 patients in Denmark and with a median age of 56 from the Danish Diet Cancer and Health Study [33]. In this study, researchers monitored these patients for 17 to 22 years and counted 8,726 atherosclerotic cardiovascular disease related hospitalization [33]. The researchers found that individuals at the highest vitamin K2 intake quintile had a 14% lower risk of atherosclerotic cardiovascular disease hospitalization compared to the lowest vitamin K2 intake quintile (Hazard Ratio = 0.86, 95% CI: 0.81-0.91) [33].

Similarly, researchers evaluated the Hordaland Health Study Cohort study from Norway in 2020 to determine if an association was present between dietary vitamin K intake and the risk of a coronary heart disease event [32]. Two thousand nine hundred and eighty-seven (2,987) men and women aged 46 to 49 from Norway were followed for a median 11 years and the researchers counted 112 CAD event cases [32]. In this study, the researchers found that those individuals in the highest vitamin K2 intake quartile had 48% lower odds of experiencing a CAD event compared to the lowest vitamin K2 intake quartile cohort (Hazard Ratio = 0.52, 95% CI: 0.29-0.94) [32].

There were many other studies that were not included in the final analysis due to differences in reported outcomes and target populations yet still suggest that use of vitamin K2 significantly supports cardiovascular health. For example, Knapen et al. investigated the use of menaquinone vitamin K2 on specific vascular biomarkers that are known to have a link to heart health in 2015 [35]. The researchers divided 240 postmenopausal healthy women free from cardiovascular disease into two groups based on their baseline arterial stiffness (i.e., stiffness index cut-off at 10.8; 50th percentile). The researchers found that use of vitamin K2 over three years had a statistically significant improvement on carotid-femoral pulse-wave velocity (cfPWV) and arterial elasticity among women in the high arterial stiffness group [35]. And in 2020, similar research was conducted exploring the link between utilization of vitamin K2 and specific vascular biomarkers among 243 men and women subjects [36]. The researchers found that women using vitamin K2 for one year had decreased mean uncarboxylated matrix Gla protein (dp-ucMGP) levels from 639 to 450 pmol/L, while in men the decrease was from 681 to 652 pmol/L, suggesting that vitamin K2 intake among women can lead to a significant reduction in age-related vascular stiffening [36].

To deduce the effect of using vitamin K2 on the occurrence of an CAD event, a random-effects meta-analysis model was developed based on the systematic review process developed by DerSimonian and Laird (1986) which is a common approach for deducing the true treatment effect from a set of clinical research citations that varies by sample size, methodologies and study protocols, and patient population dynamics [5, 37]. This approach allows for a systematic and objective approach to weighing each of the qualified reported effects and combining them to estimate an expected risk reduction factor that can be used to estimate the number of avoided events and avoided expenditures, if a given patient were to use a supplement at a given intake level [5].

Based on applying the random-effects meta-analysis model to the qualified set of clinical studies described in detail above, it is estimated that the relative risk reduction (RRR) of a CAD event, given the preventive daily use of vitamin K2 supplements, is 15.7% (95% CI: 3.2% - 25.0%) after controlling for variance caused by study sample size, research protocols, and patient population differences within each study and among all studies. Given a CAD event risk of 13% among adults aged 55 and older, the number of people that would need to use a vitamin K2 supplement to avoid one CAD event is approximately 49 (95% CI: 31-240) people. In other words, if approximately 49 people used vitamin K2 supplements at daily protective intake levels, one CAD hospitalization event would be avoided among that group. Given an NNT of 49 people, the number of potential avoided events among all U.S. adults aged 55 and over diagnosed with CAD could be an estimated 274,933 avoided events in 2022 and is expected to be an average of 301,539 events per year from 2022 to 2030 given current population and disease risk growth expectations. Table 26 describes the empirical results of the included studies in the final systematic review and Table 27 reports the aggregated expected effect size of vitamin K2 use on cardiovascular event risk.

Table 26. Vitamin K2 Literature Review: Summary of Study Findings

Author	Total sample (N)	Reported Effect Size	95% Low	95% High	Study weight (based on random effects model)
Geleijnse *et al.*	4,807	0.59	0.40	0.86	6.3%
Gast *et al.*	16,057	0.91	0.85	1.00	19.7%
Juanola-Falgarona *et al.*	7,216	0.76	0.44	1.29	4.2%
Zwakenberg *et al.*	33,289	0.86	0.74	1.00	42.8%
Haugsgjerd *et al.*	2,987	0.52	0.29	0.94	5.3%
Bellinge *et al.*	53,372	0.86	0.81	0.91	21.6%

Table 27. Expected Efficacy of Supplement Use Based on Literature Review, vitamin K2

Metric	Measure
Relative risk (weighted for intra-study variance) (RR)	0.84 (95% CI: 0.737-0.966)
Relative risk reduction (weighted for intra-study variance) (RRR)	15.7% (95% CI: 3.2%-25.0%)
Absolute risk reduction (ARR)	2.0% (95% CI: 0.4%-3.2%)
Number of people needed to treat to avoid one CAD event (NNT), people	49 (95% CI: 31-240)
Estimated number of events that could have been avoided if the entire target population used Vitamin K2 in 2022	274,933
Average number of events avoided annually if the entire target population used Vitamin K2, 2022-2030	301,539

Source: Frost & Sullivan analysis

Economic Implications

Given the risk reducing effect of using vitamin K2 on CAD-attributed event occurrence of 15.7%, which is achievable if every high-risk person in the target population were to take vitamin K2 supplements at protective levels daily, the expected reduction in expenditures in 2022 attributed to avoided CAD-attributed events would have been $8.86 billion in 2022 given an average CAD-event cost of $32,220 per case in that year. Given current population growth, disease risk growth and price inflationary factors, the expected cost savings derived from avoided CAD-attributed events caused by the use of vitamin K2 at daily protective intake levels is $10.66 billion per year in total savings from 2022 to 2030.

In order to ensure that all cost considerations are taken into account, the cost of daily use of dietary supplements ought to be included in the final accounting. Based on the review of the best-selling retail products currently sold through online sales channels, the median cost of a daily dose of vitamin K2 is approximately $0.20 per day. Given this daily cost requirement, the median annual expected cost of vitamin K2 dietary supplementation for all U.S. adults aged 55 and over would be $80.85 per person per year or $1.19 billion per year for the total population over the period 2022 to 2030. Table 28 provides a summary of the cost of dietary supplementation with vitamin K2 of the entire target population.

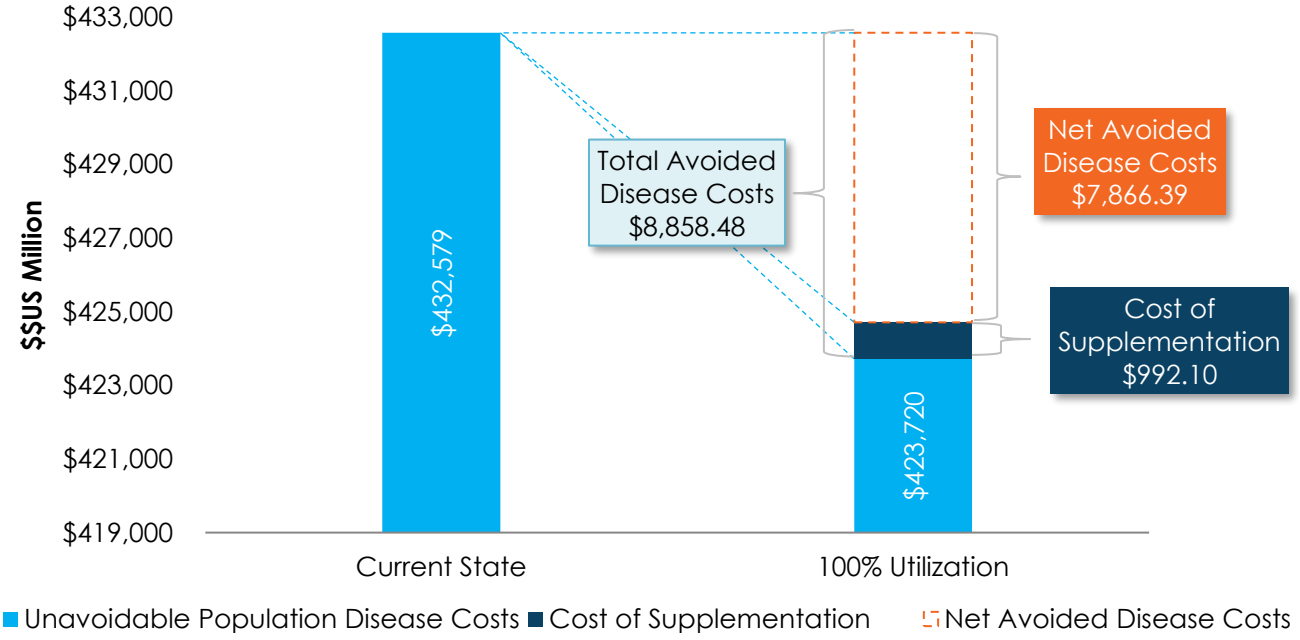
Table 28. Vitamin K2 Cost Savings Analysis: Summary Results—Cost of Dietary Supplementation of the Target Population, 2022-2030

Metric	Measure
Median daily cost per person of Vitamin K2 supplementation at protective daily intake levels, 2022	$0.20
Expected daily median cost per person of Vitamin K2 supplementation at protective daily intake levels, 2022-2030	$0.22
Median annual cost per person of Vitamin K2 supplementation at protective daily intake levels, 2022	$73.90
Expected annual median cost per person of Vitamin K2 supplementation at protective daily intake levels, 2022-2030	$80.85
Total target population cost of Vitamin K2 supplementation at protective daily intake levels, 2022	$0.99 B
Total target population cost of Vitamin K2 supplementation at protective daily intake levels, 2022-2030	$1.19 B

Note: B indicates billion. Source: Frost & Sullivan analysis

Given the incurred cost of vitamin K2 dietary supplementation, the net cost savings expected from reduced health care-attributed expenditures in 2022 from avoided CAD-attributed events would have been $7.87 billion in 2022 or $9.48 billion per year in net savings and $85.30 billion in cumulative net savings during the period 2022 to 2030. Table 29 reports the economic implications of the systematic review finding of the beneficial use of vitamin K2 supplements to support cardiovascular health.

Chart 11. Vitamin K2 Cost Savings Analysis: Health Care Cost Savings from the Use of Health Supplement, 2022 Scenario Analysis



Note: B indicates billion. Source: Frost & Sullivan analysis

Table 29. Vitamin K2 Cost Savings Analysis: Summary Results—Avoided Hospital Utilization Expenditures due to Dietary Supplement Intervention, 2022-2030

Metric	Measure
Avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention per year, 2022	$8.86 B
Average avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention per year, 2022-2030	$10.66 B
Net avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention per year, 2022 (includes cost of supplementation)	$7.87 B
Net average avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention per year, 2022-2030 (includes cost of supplementation)	$9.48 B
Net benefit cost ratio, $ Savings per one dollar spent on dietary supplement	$8.93
Cumulative net target avoided costs, 2022-2030 (NET BENEFITS) ($ billion)	$85.30 B

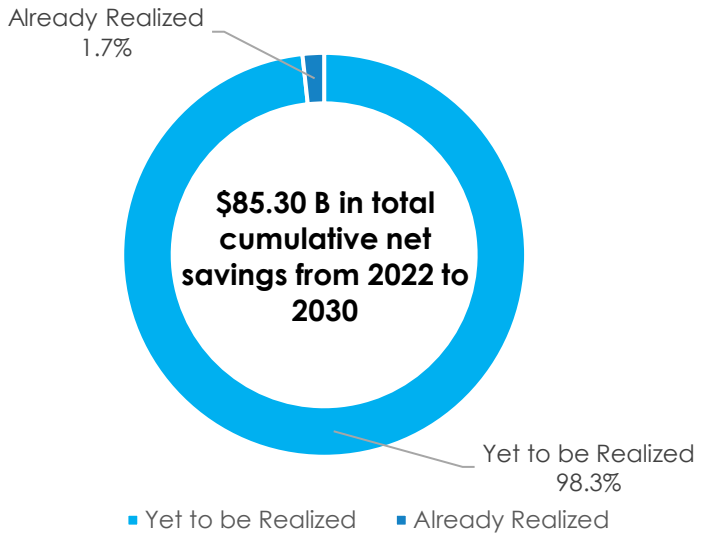
Note: B indicates billion. Source: Frost & Sullivan analysis

The above cost savings results are the maximum savings potential that is obtainable if everyone in the target population (all adults aged 55 and older) had not used this product prior to the base year of analysis (e.g., 2022) and then 100% of the population adopted the vitamin K2 regimen in the same year and gained all potential benefits. This assumption was made in order to calculate per capita net benefits which in turn can be used to calculate the net avoided cost savings for the subset of the population yet to use vitamin K2.

According to the 2021 Council for Responsible Nutrition Consumer Survey on Dietary Supplements conducted by Ipsos Public Affairs, over 40% of US adults aged 55 and older are regular users of dietary supplements and approximately 4% of supplement users aged 55 and over are regular users of vitamin K2 dietary supplements [152]. This implies that approximately 1.7% of the total population of US adults aged 55 and older are regular users of vitamin K2 dietary supplements and the remaining 98.3% of the target population has yet to realize the potential benefits of the supplements' regular use. Because avoided expenditures and net cost savings are a direct function of the total number of people in the target population using vitamin K2 dietary supplements, the calculation of avoided health care expenditures and net cost savings yet to be realized is simply a proportional adjustment of the total potential avoided expenditures and net cost savings.

Thus, it is expected that approximately $7.73 billion of the $7.87 billion in net potential direct savings from avoided CAD hospital utilization events because of vitamin K2 dietary supplement intervention is yet to be realized in total expected CAD costs. If utilization rates go unchanged, an average cost savings opportunity of $9.32 billion per year, or $83.84 billion from 2022 to 2030 in cumulative savings, could be lost because of underutilization of vitamin K2 dietary supplements. Hence it is expected that there are still significant cost savings yet be realized through the increased usage of vitamin K2 dietary supplements among the high-risk target population.

Chart 12. Vitamin K2 Cost Savings Analysis: Summary Results—Cumulative Net Cost Savings Yet to be Realized due to Avoided Hospital Utilization Expenditures through Dietary Supplement Intervention, 2022-2030



Source: Council for Responsible Nutrition

Table 30. Vitamin K2 Cost Savings Analysis: Summary Results—Net Cost Savings Yet to be Realized due to Avoided Hospital Utilization Expenditures through Dietary Supplement Intervention, 2022-2030

Metric	Measure
Net avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention yet to be realized per year, 2022	$7.73 B
Net average avoided CAD-attributed hospital utilization expenditures given Vitamin K2 supplement intervention yet to be realized per year, 2022-2030	$9.32 B
Cumulative net target avoided costs yet realized, 2022-2030 (NET BENEFITS) ($ billion)	$83.84 B

Note: B indicates billion. Source: Frost & Sullivan analysis

Detailed Results

Table 31. Vitamin K2 Cost Savings Analysis: Detailed Results—Cost of Dietary Supplementation of the Target Population, 2022-2030

Year	Vitamin K2, Daily Cost of Supplementation ($ per day)	Vitamin K2, Annual Cost of Supplementation ($ per year)	Vitamin K2, Population Cost of Supplementation ($ billion)
2021	$0.20	$72.25	$0.948
2022	$0.20	$73.90	$0.992
2023	$0.21	$75.55	$1.037
2024	$0.21	$77.23	$1.083
2025	$0.22	$78.96	$1.131
2026	$0.22	$80.72	$1.181
2027	$0.23	$82.52	$1.232
2028	$0.23	$84.36	$1.285
2029	$0.24	$86.25	$1.340
2030	$0.24	$88.17	$1.396
Average ('22-'30)	$0.22	$80.85	$1.187
CAGR	2.2%	2.2%	4.4%
Cumulative ('22-'30)	--	--	$10.679

Source: Frost & Sullivan.

Table 32. Vitamin K2 Cost Savings Analysis: Detailed Results—Avoided Hospital Utilization Expenditures due to Dietary Supplement Intervention, 2022-2030

Year	Vitamin K2 & CAD, Number of Avoided Events if 100% Utilization by Target User Base (# of Avoided Event Cases)	Vitamin K2 & CAD, Total Target Avoided Costs (BENEFITS) ($ billion)	Vitamin K2 & CAD, Net Target Avoided Costs (NET BENEFITS) ($ billion)	Vitamin K2, Benefit/Cost Ratio: $Value of Reduced Risk per $1 spent on Supplement ($/$1 supplement spend)
2021	268,287	$8.456	$7.507	$8.92
2022	274,933	$8.858	$7.866	$8.93
2023	281,582	$9.275	$8.238	$8.94
2024	288,231	$9.706	$8.623	$8.96
2025	294,882	$10.152	$9.020	$8.97
2026	301,535	$10.613	$9.432	$8.99
2027	308,188	$11.089	$9.857	$9.00
2028	314,843	$11.581	$10.296	$9.01
2029	321,500	$12.090	$10.750	$9.02
2030	328,157	$12.616	$11.220	$9.03
Average ('22-'30)	301,539	$10.665	$9.478	$8.99
CAGR	2.26%	4.55%	4.57%	2.24%
Cumulative ('22-'30)	2,713,851	$95.981	$85.302	

Source: Frost & Sullivan.

Table 33. Vitamin K2 Cost Savings Analysis: Summary Results—Net Cost Savings Yet to be Realized due to Avoided Hospital Utilization Expenditures through Dietary Supplement Intervention, 2022-2030

Year	Vitamin K2 & CAD, Total Target Avoided Costs Yet to be Realized (BENEFITS) ($ billion)	Vitamin K2 & CAD, Net Target Avoided Costs Yet to be Realized (NET BENEFITS) ($ billion)
2021	$8.31	$7.38
2022	$8.71	$7.73
2023	$9.12	$8.10
2024	$9.54	$8.47
2025	$9.98	$8.87
2026	$10.43	$9.27
2027	$10.90	$9.69
2028	$11.38	$10.12
2029	$11.88	$10.57
2030	$12.40	$11.03
Average ('22-'30)	$10.48	$9.32
CAGR	4.55%	4.57%
Cumulative ('22-'30)	$94.33	$83.84

Source: Frost & Sullivan.