Does Ginkgo biloba Reduce the Risk of Cardiovascular Events?

Lewis H. Kuller, MD, DrPH; Diane G. Ives, MPH; Annette L. Fitzpatrick, PhD; Michelle C. Carlson, PhD; Carla Mercado, MS; Oscar L. Lopez, MD; Gregory L. Burke, MD, MSc; Curt D. Furberg, MD, PhD; Steven T. DeKosky, MD; for the Ginkgo Evaluation of Memory Study Investigators

Background—Cardiovascular disease (CVD) was a preplanned secondary outcome of the Ginkgo Evaluation of Memory Study. The trial previously reported that Ginkgo biloba had no effect on the primary outcome, incident dementia.

Methods and Results—The double-blind trial randomly assigned 3069 participants over 75 years of age to 120 mg of G. biloba EGb 761 twice daily or placebo. Mean follow-up was 6.1 years. The identification and classification of CVD was based on methods used in the Cardiovascular Health Study. Differences in time to event between G. biloba and placebo were evaluated using Cox proportional hazards regression adjusted for age and sex. There were 355 deaths in the study, 87 due to coronary heart disease with no differences between G. biloba and placebo. There were no differences in incident myocardial infarction (n=164), angina pectoris (n=207), or stroke (151) between G. biloba and placebo. There were 24 hemorrhagic strokes, 16 on G. biloba and 8 on placebo (not significant). There were only 35 peripheral vascular disease events, 12 (0.8%) on G. biloba and 23 (1.5%) on placebo (P=0.04, exact test). Most of the peripheral vascular disease cases had either vascular surgery or amputation.

Conclusions—There was no evidence that G. biloba reduced total or CVD mortality or CVD events. There were more peripheral vascular disease events in the placebo arm. G. biloba cannot be recommended for preventing CVD. Further clinical trials of peripheral vascular disease outcomes might be indicated.

Clinical Trial Registration—clinicaltrials.gov Identifier: NCT00010803
(Circ Cardiovasc Qual Outcomes. 2010;3:00-00.)

Key Words: anticoagulation • peripheral vascular disease • cardiovascular disease • stroke • trials

We report the vascular disease secondary end points from the Ginkgo Evaluation of Memory Study (GEMS) of Ginkgo biloba, a randomized, double-blind, placebo-controlled clinical trial conducted between 2000 and 2008.1,2 Vascular end points included cardiovascular disease (CVD), defined as angina pectoris, myocardial infarction (MI), congestive heart failure (CHF), stroke/cerebrovascular accident (CVA), transient ischemic attack (TIA), peripheral vascular disease (PVD), and CV-related deaths. There have been no previous clinical trials to evaluate whether G. biloba, a highly purified extract of G. biloba, prevents CVD.3-5 We reported previously that G. biloba had no effect on the primary outcome, incidence of dementia, and Alzheimer disease.2

G. biloba has been widely used in Europe for the treatment of PVD. Randomized clinical trials have suggested that G. biloba is associated with increasing walking distance before the development of symptoms of lower extremity pain, that is, intermittent claudication.6 The physiological effects of G. biloba on the cardiovascular system are uncertain. Several studies have suggested antioxidant and free-radical scavenger effects. There is also suggestion of inhibition of platelet aggregation. There have been reports of association G. biloba with bleeding, which has been attributed to antiplatelet aggregation effects. It was also suggested that G. biloba improved blood flow by increased release of nitric oxide and the inhibition of nitric oxide degradation in the endothelium.7-10

Flavonoids are a component of G. biloba. There is considerable interest in the potential antioxidant, anti-inflammatory, vasodilation, and platelet inhibition activity by various flavonoids. Several but not necessarily all large longitudinal studies have suggested some benefit of overall consumption of flavonoids on the risk of coronary heart disease (CHD).11-18
WHAT IS KNOWN

- Ginkgo biloba is a flavonoid that has previously been shown to improve walking in patients with peripheral vascular disease.

WHAT THE STUDY ADDS

- In a secondary end point analysis of G. biloba in the Ginkgo Evaluation of Memory Study, G. biloba did not reduce incidence or mortality from coronary heart disease or stroke.
- There were fewer peripheral vascular disease events in participants taking G. biloba (n=12, 8%) than placebo (n=23, 15%) (P=0.04).
- G. biloba may reduce risk of peripheral vascular disease, especially among high-risk individuals with low ankle-brachial index.
- This positive effect on peripheral vascular disease is consistent with previous studies and requires further evaluation in larger trials before implementation in clinical practice.

Methods

A detailed description of the study methods and recruitment has been published. The study was conducted under an investigational new drug application with the Food and Drug Administration under the auspices of the National Center of Complementary and Alternative Medicine (NCCAM). The study was built on the infrastructure of the Cardiovascular Health Study (CHS) clinical study at the University of Pittsburgh, University of California Davis, Johns Hopkins University, and Wake Forest University. A Clinical Coordinating Center located at the University of Pittsburgh was responsible for overseeing clinical operations. The Cognitive Diagnostic Center was located at the University of Pittsburgh. The Data Coordinating Center was at the University of Vermont.

Recruitment and Eligibility

Participants were recruited both from the CHS and volunteers in the communities. Recruitment was done in 3 phases: cognitive and medical or other exclusions were identified at each phase. The Telephone Interview for Cognitive Status was used to screen potential participants before inviting them into the clinic for further screening. During the initial screening visit, participants completed several cognitive screening tests and additional neuropsychological testing, phlebotomy, and functional assessment. Eligibility for the trial included no current dementia, willingness to participate for 5 years in the trial, age at least 75 years, English speaking, and normal levels of specific blood tests (Table 1). Participants with neurological or neurodegenerative diseases were excluded from the study. Anyone receiving cognitive enhancers or other treatment of Alzheimer disease were excluded, as were individuals taking high doses of vitamin E or taking over-the-counter G. biloba. Subjects taking anticoagulants were excluded. Eligible participants were invited back for a baseline visit for further eligibility review and random assignment.

The baseline examination included a physical examination and a neurological examination, ECG, and ankle-brachial index (ABI) measurement. Individuals with prior CVD were allowed into the study. However, individuals having prevalent CHF with disability were excluded. Persons found to have abnormal levels of thyroid-stimulating hormones, serum B12, hematocrit, white blood cell count, or platelets at the screening visit were also excluded.

Randomization

Enrolled participants were randomly assigned to 120 mg G. biloba or placebo to be taken twice per day. Randomization was done separately for each clinic site. Assignment to G. biloba or placebo was determined by permuted block design by site to ensure that allocation between treatment groups was well balanced. Participants assigned to active treatment and placebo were kept in their randomly assigned group regardless of their drug compliance, in accordance with an intention-to-treat analysis. All clinic center personnel and participants were blinded to treatment assignment for the duration of the study. Semiannual visits included pulse, blood pressure, current medications, interval medical history and adverse events, functional assessment, drug adherence, and cognitive evaluations.

Ascertainment of CHD Events

At each 6-month visit and interim 3-month drug adherence monitoring phone call, subjects or their proxies were asked to report serious adverse events in compliance with Food and Drug Administration regulations. All subjects provided authorization to release medical records. All serious adverse events reported as overnight hospitalizations or deaths were investigated through the collection of medical records and reviewed by a blinded field center physician investigator. Records used for review included hospital face sheets with International Classification of Diseases (ICD), Ninth Revision, diagnostic codes, discharge summaries, history and physical examinations, and other documents, depending on the diagnosis. Noncertified death certificates with cause of death were obtained for fatal events.

Identification and classification of vascular outcomes were based on methods from the CHS. Each field center abstracted the ICD codes for diagnoses from the hospitalization face sheet, and codes were searched to flag any possible vascular outcomes. Local physicians were also required to determine whether the hospitalization was due to a cardiovascular or cerebrovascular cause or if the serious adverse event resulted in death. Case records with vascular ICD codes were marked by the local physician as being in any of the vascular disease categories were forwarded to the University of Pittsburgh for abstraction and adjudication. In addition to the face sheet, discharge summary, and history and physical examination, review of coronary events included cardiac consults and diagnostic laboratory tests and procedures. Cerebrovascular event reviews also included neurological consults. Vascular outcomes were defined as MI, angina pectoris, CHF, CVA/stroke, TIA, PVD, and coronary revascularization. Cases from all 4 clinical centers were classified by 2 reviewers of the University of Pittsburgh blinded to treatment assignment. All deaths were classified by underlying cause of death using death certificates and, if applicable, hospital records and autopsy reports. The classification included atherosclerotic CHD (subclassified as definite fatal MI, definite fatal CHD, or possible fatal CHD), cerebrovascular disease (including stroke/CVA or late effect of stroke), atherosclerotic cardiovascular disease noncoronary (including ruptured aortic aneurysm), other cardiovascular disease not CHD or CVA (including valvular heart disease and pulmonary embolism), and all other causes. Morbid CVD events were classified as definite, probable, or not present.

Drug Treatment

Participants were randomly assigned to twice-daily doses of either 120 mg G. biloba extract or an identically appearing placebo. G. biloba EGb 761 was supplied for the study by the Schwabe Pharmaceuticals (Karlsruhe, Germany). A 120-mg dose in pill form containing 28.8 mg of G. biloba flavone glycosides and 7.2 mg of terpene lactones was prepared for use in this study. These values were confirmed by an independent laboratory for each batch of product used in the GEMS.
Statistical Methods

Descriptive of demographic characteristics within each treatment group were calculated as count and percent for discrete variables and mean with standard deviations for continuous variables. The following endpoints were combined for additional analysis: MI and angina pectoris for CHD; stroke and TIA for CVA; and the combination of CHD and CVA. Time-to-event analyses comparing *G biloba* with placebo were completed on (a) total and CVD deaths, (b) incident CVD events (time to first event) for persons reported to be free of the specific outcome at baseline, and (c) total CVD events (time to first event), allowing both incident and recurrent outcomes to be included. Calculation of rates for incident cardiovascular events excluded those participants who reported the specific condition at baseline. For the combination of incident and prevalent events, all participants were included in the analysis. Person-time in years was calculated as days between date of the baseline clinic visit to the day of the first occurrence of either the cardiovascular event of interest, death, dementia, or last follow-up visit.2

Differences in time to events between *G biloba* and placebo were evaluated using Cox proportional hazards regression adjusted for sex and age, using a categorical variable for adjustment in the models (<80 years, 80 to 84 years, and ≥85 years). Differences in incidence rates of MI and stroke were also calculated and presented per year in the study using the binomial exact test. All analysis was performed using Stata version 10 (StataCorp, College Station, Tex). Power estimates were originally based on rates from the CHS, age ≥75, stroke 2%, CHD end point 5%. Based on those estimates, we had 89% power for a 35% reduction for stroke, 75% power for a 30% decrease, and for CHD 99% power for a 35% reduction and 92% power for a 25% reduction.1 The overall incidence of composite CVD events in the GEMS was approximately 4% per year and for stroke and TIA 1.5% per year.

Results

There were 3069 community volunteers age ≥75 (mean age, 79 years) randomly assigned to placebo (n=1524) or *G biloba* (n=1545) 120 mg twice daily (Table 1). Approximately 95% of the participants were white; 23% had some postgraduate education. One quarter of the participants had a

### Table 1. Demographic and Risk Factors at Randomization: *G biloba* Versus Placebo Versus CHS, Baseline Age 75 to 84 Years

<table>
<thead>
<tr>
<th>Age, y</th>
<th>G biloba</th>
<th>Placebo</th>
<th>Total</th>
<th>CHS, Ages 75–84 y (n=1765)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>&lt;80</td>
<td>1027</td>
<td>66.5</td>
<td>1004</td>
<td>65.9</td>
</tr>
<tr>
<td>80–84</td>
<td>418</td>
<td>27.1</td>
<td>430</td>
<td>28.2</td>
</tr>
<tr>
<td>≥85</td>
<td>100</td>
<td>6.5</td>
<td>90</td>
<td>5.9</td>
</tr>
<tr>
<td>White</td>
<td>1482</td>
<td>95.9</td>
<td>1448</td>
<td>95.0</td>
</tr>
<tr>
<td>Male</td>
<td>843</td>
<td>54.6</td>
<td>808</td>
<td>53.0</td>
</tr>
</tbody>
</table>

**Education**

<table>
<thead>
<tr>
<th></th>
<th>G biloba</th>
<th>Placebo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school or less</td>
<td>570</td>
<td>36.9</td>
<td>534</td>
</tr>
<tr>
<td>Some college</td>
<td>381</td>
<td>24.7</td>
<td>395</td>
</tr>
<tr>
<td>College graduate</td>
<td>251</td>
<td>16.3</td>
<td>229</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>343</td>
<td>22.2</td>
<td>366</td>
</tr>
</tbody>
</table>

**Self-reported history**

<table>
<thead>
<tr>
<th></th>
<th>G biloba</th>
<th>Placebo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart attack</td>
<td>148</td>
<td>9.6</td>
<td>162</td>
</tr>
<tr>
<td>Angina</td>
<td>157</td>
<td>10.2</td>
<td>147</td>
</tr>
<tr>
<td>Stroke</td>
<td>43</td>
<td>2.8</td>
<td>45</td>
</tr>
<tr>
<td>Heart failure</td>
<td>28</td>
<td>1.8</td>
<td>33</td>
</tr>
<tr>
<td>Hypertension</td>
<td>383</td>
<td>53.9</td>
<td>383</td>
</tr>
<tr>
<td>Diabetes</td>
<td>139</td>
<td>9.1</td>
<td>138</td>
</tr>
</tbody>
</table>

**Smoking history**

<table>
<thead>
<tr>
<th></th>
<th>G biloba</th>
<th>Placebo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>602</td>
<td>39.2</td>
<td>622</td>
</tr>
<tr>
<td>Former</td>
<td>846</td>
<td>55.1</td>
<td>805</td>
</tr>
<tr>
<td>Current</td>
<td>71</td>
<td>4.6</td>
<td>65</td>
</tr>
</tbody>
</table>

**Systolic blood pressure**

<table>
<thead>
<tr>
<th></th>
<th>G biloba</th>
<th>Placebo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (&lt;20 kg/m²)</td>
<td>33</td>
<td>2.1</td>
<td>46</td>
</tr>
<tr>
<td>Normal (20–25 kg/m²)</td>
<td>463</td>
<td>30.1</td>
<td>447</td>
</tr>
<tr>
<td>Overweight (25–30 kg/m²)</td>
<td>722</td>
<td>47.0</td>
<td>688</td>
</tr>
<tr>
<td>Obese (≥30 kg/m²)</td>
<td>319</td>
<td>20.8</td>
<td>340</td>
</tr>
</tbody>
</table>

All differences between GEMS and CHS are statistically significant (P<0.05), except for diastolic blood pressure.
history of CVD, approximately 55% reported history of hypertension, and 9% had diabetes. Only 4.5% currently smoked cigarettes.

Recruitment began in September 2000 to June 2002. Participant close-out began in October 2007 and was completed in April 2008. Median follow-up was 6.1 years, with a maximum of 7.3 years. Adherence varied from 90% at 6 months, 79% at 2 years, 73% at 4 years, and at the end of the trial, 60.3% of those receiving active therapy were taking their assigned study medication. Adherence did not differ between those taking G. biloba and those taking placebo.

Deaths
There were 385 deaths during the trial: 188 (22.2/1000 person-years) in the placebo group and 197 (23.0/1000 person-years) in the G. biloba active arm (Table 2). Eighty-seven of the deaths were due to CHD; 42 in the placebo group and 45 in G. biloba arm. There were no differences in the distribution of other CV or non-CV deaths by treatment arm. There were also no differences in distribution of deaths by G. biloba versus placebo for men (210, 12.8%) or women (175, 12.3%).

Hospitalized CV Events
There were 164 hospitalized clinical MIs, 207 cases of reported angina pectoris, 151 strokes, 73 TIAs, and 35 PVD events. The measurement of incident CVD was limited, as noted, to those individuals who had no self-reported baseline history of CVD and had their first event during the trial. There were no significant differences in incidence of any of the CV outcomes by G. biloba versus placebo arm (Table 3). Event rates were slightly higher in men than in women, except for stroke. There was, however, no difference in event rates by sex by arm in the trial.

There was no evidence of any reduction in risk of total CVD or CHD events, including recurrent events, for G. biloba versus placebo for men or women. No differences were found between the G. biloba and placebo arms of the study for incident plus recurrent CV events (Table 4).

Stroke
Incidence of stroke was slightly higher in the G. biloba than in the placebo arm of the trial, but the difference was not statistically significant (Table 3). Mortality rate for stroke

---

**Table 2. Total and Cardiovascular Deaths: G. biloba Versus Placebo**

<table>
<thead>
<tr>
<th></th>
<th>G. biloba</th>
<th></th>
<th>Placebo</th>
<th></th>
<th></th>
<th>Age- and Sex-Adjusted HR (95% CI)</th>
<th>Statistically Different P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
<td>Rate per 1000 Person-Years</td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
</tr>
<tr>
<td>1. Atherosclerotic CHD</td>
<td>24</td>
<td>21</td>
<td>45</td>
<td>5.3</td>
<td>24</td>
<td>18</td>
<td>42</td>
</tr>
<tr>
<td>2. CVD</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>1.4</td>
<td>12</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>3. Other atherosclerotic, not coronary or cerebrovascular</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>0.6</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4. Other cardiovascular disease, not atherosclerotic</td>
<td>5</td>
<td>6</td>
<td>11</td>
<td>1.3</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>5. All CHD and CVD combined (1 through 4)</td>
<td>36</td>
<td>37</td>
<td>73</td>
<td>8.5</td>
<td>44</td>
<td>33</td>
<td>77</td>
</tr>
<tr>
<td>6. Noncardiovascular</td>
<td>68</td>
<td>56</td>
<td>124</td>
<td>14.5</td>
<td>62</td>
<td>49</td>
<td>111</td>
</tr>
<tr>
<td>7. Total deaths</td>
<td>104</td>
<td>93</td>
<td>197</td>
<td>23.0</td>
<td>106</td>
<td>82</td>
<td>188</td>
</tr>
</tbody>
</table>

HR indicates hazard ratio, calculated by Cox proportional hazard model.
*P value calculated by Cox proportional hazard model adjusted for age and sex.

---

**Table 3. Hospitalizations for Incident Cardiovascular Events Based on No Self-Reported Baseline History, Fatal and Nonfatal by Subject, G. biloba Versus Placebo by Sex**

<table>
<thead>
<tr>
<th></th>
<th>G. biloba</th>
<th></th>
<th>Placebo</th>
<th></th>
<th></th>
<th>Age- and Sex-Adjusted HR (95% CI)</th>
<th>Statistically Different P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
<td>Rate per 1000 Person-Years</td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
</tr>
<tr>
<td>1. MI</td>
<td>41</td>
<td>27</td>
<td>68</td>
<td>9.0</td>
<td>25</td>
<td>35</td>
<td>60</td>
</tr>
<tr>
<td>2. Angina</td>
<td>43</td>
<td>23</td>
<td>66</td>
<td>8.9</td>
<td>53</td>
<td>23</td>
<td>76</td>
</tr>
<tr>
<td>3. CHD (MI and/or angina)</td>
<td>66</td>
<td>41</td>
<td>107</td>
<td>15.5</td>
<td>60</td>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>4. CHF</td>
<td>65</td>
<td>47</td>
<td>112</td>
<td>13.9</td>
<td>58</td>
<td>64</td>
<td>122</td>
</tr>
<tr>
<td>5. Stroke</td>
<td>39</td>
<td>34</td>
<td>73</td>
<td>9.0</td>
<td>22</td>
<td>37</td>
<td>59</td>
</tr>
<tr>
<td>6. TIA</td>
<td>17</td>
<td>10</td>
<td>27</td>
<td>3.5</td>
<td>16</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td>7. CVD (stroke and/or TIA)</td>
<td>57</td>
<td>42</td>
<td>99</td>
<td>13.0</td>
<td>38</td>
<td>50</td>
<td>88</td>
</tr>
<tr>
<td>8. Total CHD and CVD combined (3 and 8)</td>
<td>93</td>
<td>64</td>
<td>157</td>
<td>24.9</td>
<td>75</td>
<td>79</td>
<td>154</td>
</tr>
</tbody>
</table>

HR indicates hazard ratio, calculated by Cox proportional hazard model.
*P value calculated by Cox proportional hazard model adjusted for age and sex.
There were only 35 PVD events in the trial: 12 (0.8%) in the G biloba arm and 23 (1.5%) on placebo (P=0.04 exact test). Most (27 of 35 [77%]) PVD cases had a surgical, revascularization, or amputation procedure for symptomatic PVD: 18 of 23 (78.3%) on placebo and 9 of 12 (75.0%) on G biloba. There was 1 case of popliteal aneurysm secondary to a diagnostic procedure in the placebo arm. The risk of PVD, incident CHD, or total mortality was related directly to ABI at baseline, with most cases occurring in participants with ABI ≤1.1 (Table 5). The incidence of PVD was 10.2/1000 person-years in the G biloba arm and 16.9/1000 person-years in the placebo arm (P=0.12). Of the 24 hemorrhagic strokes, 2 were subarachnoid hemorrhage and 22 were intracranial hemorrhage. Five of 16 participants in the G biloba arm and 2 of 8 in the placebo arm were off therapy at the time of the intracranial hemorrhage. Only 2 participants were taking anticoagulants at the visit before hemorrhagic stroke (medical need required cessation of drug, although subjects were still followed). Thus, 11 hemorrhagic strokes occurred on treatment with G biloba, and 6 such strokes occurred in the placebo arm (not statistically significant).

Rates of major bleeding did not differ between treatment groups (hazard ratio, 0.97 [0.77 to 1.23]; P=0.81). The incidence of bleeding did not differ by use of aspirin therapy assigned to either G biloba or placebo (1.98 versus 1.76/100 person-years, P=0.44).1

**Peripheral Vascular Disease**

There were only 35 PVD events in the trial: 12 (0.8%) in G biloba arm and 23 (1.5%) on placebo (P=0.04 exact test). Most (27 of 35 [77%]) PVD cases had a surgical, revascularization, or amputation procedure for symptomatic PVD: 18 of 23 (78.3%) on placebo and 9 of 12 (75.0%) on G biloba. There was 1 case of popliteal aneurysm secondary to a diagnostic procedure in the placebo arm. The risk of PVD, incident CHD, or total mortality was related directly to ABI at baseline, with most cases occurring in participants with ABI ≤1.1 (Table 5). The incidence of PVD was 10.2/1000 person-years for ABI <0.9 in the G biloba arm (n=7) versus 17.5/1000 person-years for placebo (n=12) (P=0.26). For participants who entered with ABI in the 3rd or 4th quartile ≥1.1, there were only 2 events in the G biloba arm and 4 in the placebo group. Two participants did not have measurement of ABI at baseline. We further reviewed records that had some PVD codes on hospital discharge records but did not reach criteria for clinical PVD in the study. There were 54 records; 16 had a history of lower extremity PVD in the hospital record, usually a history of claudication but no concurrent therapy (7 in the G biloba arm and 9 in the placebo arm).

**Age Effects**

We further evaluated the incidence of CV events by age at entry to the trial, <80 years, 80 to 84 years, and ≥85 years (not shown). There were no differences in the incidence of any of the CV outcomes in any age group as defined by age at entry to the trial. The incidence of CHD, MI, and angina pectoris increased little by age (from 14.3/1000 person-years for age <80 years to 16.3/1000 person-years for age ≥85 years). The incidence of CHF, however, increased dramatically from 14.35 in those <80 years to 30.1/1000 person-years in those age ≥85 years. There was also no difference in the incidence of MI or stroke by time in the trial for G biloba versus placebo (not shown).

**Discussion**

GEMS did not demonstrate that G biloba 120 mg twice daily in older individuals age ≥75 years reduced the risk of either CHD or CVD mortality, total hospitalizations, or incident CVD/CHD events. G biloba 120 mg twice daily cannot be recommended for prevention of CV mortality or incident or recurrent CVD/CHD events in this age group. Results were similar for men or women or by age groups for incidence or mortality by G biloba versus placebo. There is no evidence of any benefit by longer duration in the trial. It remains possible, however, that the benefits of G biloba, should there be any, require many years of therapy, perhaps beginning at an earlier age. GEMS participants probably had extensive atherosclerotic disease even without a history of clinical disease. The potential physiological effects of G biloba on thrombosis, for example, platelet function and endothelial function,1,2,4 would have been expected to decrease the incidence of CVD/CHD if there was a true benefit. It is also possible that G biloba reduces the risk of CHD if taken at younger ages.

There were only 35 peripheral vascular events in the trial. The difference between G biloba12 and placebo22 was significant but based on very small numbers. These results are
consistent with studies in Europe that reported increased walking time or distance without pain in trials of *G. biloba* versus placebo among clinical PVD patients.\(^6\)\(^{,}21\) A recent report from the Stanford Prevention Research Center evaluated pain-free walking distance among 62 adults with claudication symptoms. Maximal treadmill walking time increased 20±80 seconds (10%) in the placebo group and 91±242 seconds (40%) in the participants given 300 mg of EGb 761 *G. biloba* over a 4-month period (\(P=0.12\)). Lack of statistical significance may have been due to the small sample size. There was also substantial heterogeneity of the results.\(^22\)

A randomized trial from Australia, using 22 subjects, noted that exercise but not *G. biloba* improved walking times in patients with PVD.\(^23\) The PVD cases in GEMS had severe PVD, usually requiring surgery or amputation. We do not have data on symptomatic PVD that did not require hospitalization or surgical procedure, such as outpatient diagnoses. The number of events is too small to determine definitively whether *G. biloba* might have a unique effect on PVD.\(^4\) We measured ankle-brachial blood pressure at entry to the trial but did not have repeat measures of ankle-brachial blood pressure or other measures of PVD during the trial. We also did not measure out-of-hospital PVD diagnoses or hospitalizations that included PVD but in which there was not a specific diagnostic or surgical procedure for PVD. It is possible that *G. biloba* has a unique effect on PVD by increasing blood flow secondary to effects on endothelial function, for example, nitric oxide.\(^4\)\(^,\)\(^6\) A larger study would be needed to evaluate the PVD end point.

The higher number of cerebral hemorrhages (16 in *G. biloba* arm versus 8 in placebo and 11 versus 6 in the groups on treatment) would also be consistent with the reported increased risk of bleeding among patients taking *G. biloba*.\(^21\)

A limitation of this trial is the absence of measures of blood levels or urinary excretion of the flavonoids or terpenoids in participants on EGb 761 *G. biloba*. We were limited to data on drug ‘adherence’ in 2 arms and analysis of the chemical composition of the pills.\(^3\) It is very difficult to measure the amount of *G. biloba* that was absorbed and their metabolic products.\(^24\) One study has successfully reported isolation of both quercetin and kaempferol in blood. One small sample of older individuals reported similar absorption in elderly versus younger individuals.\(^25\) The other major limitation of the study is the absence of measures of PVD at the end of the trial. There is no evidence at the present time from clinical trials that *G. biloba* reduces the risk of CVD, either primary or secondary prevention.

An important issue is whether the reduced risk of clinical PVD is strong enough for either a new larger trial of *G. biloba* or for clinical use for older individuals with low ABI. A new clinical trial probably would have to be restricted to individuals with low ABI, that is, first quartile, <1. The trial would be limited by high risk of CHD, stroke, and other medication use, especially statins, aspirin, antihypertensive therapy, and diabetes mellitus. A large sample size and need for careful measurement of PVD outcomes would be required.

We do not believe that the results of the GEMS trial are a definitive indication for use of *G. biloba* for individuals with low ABI but do add to the data on potential benefit of *G. biloba* in PVD.

### Table 5. Baseline ABI Quartiles in Treatment Groups for Incident CHD, PVD, and All-Cause Mortality

<table>
<thead>
<tr>
<th></th>
<th>G biloba</th>
<th>Rate per 1000</th>
<th>Placebo</th>
<th>Rate per 1000</th>
<th>Total</th>
<th>Statistically Different</th>
<th>Statistically Different</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
<td>n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incident PVD</td>
<td>4th quartile</td>
<td>2 18</td>
<td>0.90</td>
<td>3 14</td>
<td>1.46</td>
<td>5</td>
<td>0.634</td>
</tr>
<tr>
<td></td>
<td>3rd quartile</td>
<td>0 0</td>
<td>0</td>
<td>1 4</td>
<td>0.41</td>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>2nd quartile</td>
<td>2 18</td>
<td>1.18</td>
<td>3 14</td>
<td>1.69</td>
<td>5</td>
<td>0.679</td>
</tr>
<tr>
<td></td>
<td>1st quartile</td>
<td>7 64</td>
<td>10.24</td>
<td>12 55</td>
<td>17.54</td>
<td>19</td>
<td>0.255</td>
</tr>
<tr>
<td>Incident CHD</td>
<td>4th quartile</td>
<td>32 19</td>
<td>14.88</td>
<td>38 24</td>
<td>19.50</td>
<td>70</td>
<td>0.237</td>
</tr>
<tr>
<td></td>
<td>3rd quartile</td>
<td>42 24</td>
<td>18.78</td>
<td>34 21</td>
<td>14.58</td>
<td>76</td>
<td>0.296</td>
</tr>
<tr>
<td></td>
<td>2nd quartile</td>
<td>35 20</td>
<td>21.55</td>
<td>36 23</td>
<td>21.37</td>
<td>71</td>
<td>0.989</td>
</tr>
<tr>
<td></td>
<td>1st quartile</td>
<td>63 37</td>
<td>32.89</td>
<td>51 32</td>
<td>26.79</td>
<td>114</td>
<td>0.230</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤0.9</td>
<td>3rd quartile</td>
<td>42 24</td>
<td>18.78</td>
<td>34 21</td>
<td>14.58</td>
<td>76</td>
<td>0.296</td>
</tr>
<tr>
<td></td>
<td>2nd quartile</td>
<td>35 20</td>
<td>21.55</td>
<td>36 23</td>
<td>21.37</td>
<td>71</td>
<td>0.989</td>
</tr>
<tr>
<td></td>
<td>1st quartile</td>
<td>63 37</td>
<td>32.89</td>
<td>51 32</td>
<td>26.79</td>
<td>114</td>
<td>0.230</td>
</tr>
<tr>
<td></td>
<td>4th quartile</td>
<td>32 19</td>
<td>14.88</td>
<td>38 24</td>
<td>19.50</td>
<td>70</td>
<td>0.237</td>
</tr>
<tr>
<td></td>
<td>3rd quartile</td>
<td>50 27</td>
<td>21.26</td>
<td>37 21</td>
<td>15.31</td>
<td>87</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td>2nd quartile</td>
<td>35 20</td>
<td>21.55</td>
<td>36 23</td>
<td>21.37</td>
<td>71</td>
<td>0.989</td>
</tr>
<tr>
<td></td>
<td>1st quartile</td>
<td>63 37</td>
<td>32.89</td>
<td>51 32</td>
<td>26.79</td>
<td>114</td>
<td>0.230</td>
</tr>
<tr>
<td></td>
<td>4th quartile</td>
<td>32 19</td>
<td>14.88</td>
<td>38 24</td>
<td>19.50</td>
<td>70</td>
<td>0.237</td>
</tr>
</tbody>
</table>

*First quartile, <1.02; 2nd quartile, 1.02 to 1.1; 3rd quartile, 1.1 to 1.185; 4th quartile, >1.185.*

\(*P* value calculated by Cox proportional hazard model adjusted for age and sex.

\(†P\) value calculated by Cox proportional hazard model adjusted for age and sex in each ABI.

---

**Incident CHD**

- **≤0.9:**
  - **G. biloba:** 7 64
  - **Placebo:** 12 55
  - **Total:** 19
  - **Statistically Different:** 0.255

- **1st quartile:**
  - **G. biloba:** 10.24
  - **Placebo:** 17.54
  - **Total:** 19
  - **Statistically Different:** 0.255

- **2nd quartile:**
  - **G. biloba:** 3.44
  - **Placebo:** 7.62
  - **Total:** 22
  - **Statistically Different:** 0.082

- **3rd quartile:**
  - **G. biloba:** 1.18
  - **Placebo:** 1.69
  - **Total:** 5
  - **Statistically Different:** 0.679

- **4th quartile:**
  - **G. biloba:** 0.90
  - **Placebo:** 1.46
  - **Total:** 5
  - **Statistically Different:** 0.634

**Incident PVD**

- **≤0.9:**
  - **G. biloba:** 7 64
  - **Placebo:** 12 55
  - **Total:** 19
  - **Statistically Different:** 0.255

- **1st quartile:**
  - **G. biloba:** 10.24
  - **Placebo:** 17.54
  - **Total:** 19
  - **Statistically Different:** 0.255

- **2nd quartile:**
  - **G. biloba:** 3.44
  - **Placebo:** 7.62
  - **Total:** 22
  - **Statistically Different:** 0.082

- **3rd quartile:**
  - **G. biloba:** 1.18
  - **Placebo:** 1.69
  - **Total:** 5
  - **Statistically Different:** 0.679

- **4th quartile:**
  - **G. biloba:** 0.90
  - **Placebo:** 1.46
  - **Total:** 5
  - **Statistically Different:** 0.634

**All-cause mortality**

- **≤0.9:**
  - **G. biloba:** 28 15
  - **Placebo:** 33 18
  - **Total:** 61
  - **Statistically Different:** 0.558

- **1st quartile:**
  - **G. biloba:** 39.92
  - **Placebo:** 46.14
  - **Total:** 61
  - **Statistically Different:** 0.558

- **2nd quartile:**
  - **G. biloba:** 28.77
  - **Placebo:** 31.85
  - **Total:** 123
  - **Statistically Different:** 0.645

- **3rd quartile:**
  - **G. biloba:** 21.26
  - **Placebo:** 15.31
  - **Total:** 87
  - **Statistically Different:** 0.140

- **4th quartile:**
  - **G. biloba:** 14.88
  - **Placebo:** 19.50
  - **Total:** 70
  - **Statistically Different:** 0.237
Sources of Funding
This study was supported by U01 AT000162 from the National Center for Complementary and Alternative Medicine and the Office of Dietary Supplements and by the National Institute on Aging; the National Heart, Lung, and Blood Institute; the University of Pittsburgh Alzheimer’s Disease Research Center (P50AG05133); the Roena Kulynych Center for Memory and Cognition Research; and the National Institute of Neurological Disorders and Stroke. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Center for Complementary and Alternative Medicine or the National Institutes of Health.

Disclosures
None.

References
Does Ginkgo biloba Reduce the Risk of Cardiovascular Events?
Lewis H. Kuller, Diane G. Ives, Annette L. Fitzpatrick, Michelle C. Carlson, Carla Mercado, Oscar L. Lopez, Gregory L. Burke, Curt D. Furberg, Steven T. DeKosky and for the Ginkgo Evaluation of Memory Study Investigators

Circ Cardiovasc Qual Outcomes. published online November 24, 2009:
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2009 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circoutcomes.ahajournals.org/content/early/2009/11/24/CIRCOUTCOMES.109.871640

Data Supplement (unedited) at:
http://circoutcomes.ahajournals.org/content/suppl/2009/11/24/CIRCOUTCOMES.109.871640.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Quality and Outcomes can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Quality and Outcomes is online at:
http://circoutcomes.ahajournals.org//subscriptions/
APPENDIX

GEM Study Personnel

Project Office
Richard L. Nahin, PhD, MPH, Barbara C. Sorkin, PhD, National Center for Complementary and Alternative Medicine

Clinical Centers
Michelle Carlson, PhD, Linda Fried, MD, MPH, Pat Crowley, MS, Claudia Kawas, MD, Paulo Chaves, MD, PhD, Sevil Yasar, MD, PhD, Patricia Smith, Joyce Chabot, John Hopkins University; John Robbins, MD, MHS, Katherine Gundling, MD, Sharene Theroux, CCRP, Lisa Pastore, CCRP, University of California-Davis; Lewis Kuller, MD, DrPH, Roberta Moyer, CMA, Cheryl Albig, CMA, University of Pittsburgh; Gregory Burke, MD, Steve Rapp, PhD, Dee Posey, Margie Lamb, RN, Wake Forest University School of Medicine

Schwabe Pharmaceuticals
Robert Hörr, MD, Joachim Herrmann, PhD.

Data Coordinating Center
Richard A. Kronmal, PhD, Annette L. Fitzpatrick, PhD, Fumei Lin, PhD, Cam Solomon, PhD, Alice Arnold, PhD, University of Washington

Cognitive Diagnostic Center
Steven DeKosky, MD, Judith Saxton, PhD, Oscar Lopez, MD, Beth Snitz PhD, M. Ilyas Kamboh PhD, Diane Ives, MPH, Leslie Dunn, MPH, University of Pittsburgh

Clinical Coordinating Center
Curt Furberg, MD, PhD, Jeff Williamson, MD, MHS; Nancy Woolard, Kathryn Bender, Pharm.D., Susan Margitić, MS, Wake Forest University School of Medicine

Central Laboratory
Russell Tracy, PhD, Elaine Cornell, UVM, University of Vermont

MRI Reading Center
William Rothfus MD, Charles Lee MD, Rose Jarosz, University of Pittsburgh

Data Safety Monitoring Board
Richard Grimm, MD, PhD (Chair), University of Minnesota; Jonathan Berman, MD, PhD (Executive Secretary), National Center for Complementary and Alternative Medicine; Hannah Bradford, M.Ac., L.Ac., MBA, Carlo Calabrese, ND MPH, Bastyr University Research Institute; Rick Chappell, PhD, University of Wisconsin Medical School; Kathryn Connor, MD, Duke University Medical Center; Gail Geller, ScD, Johns Hopkins Medical Institute; Boris Iglewicz, Ph.D, Temple University; Richard S. Panush, MD, Department of Medicine Saint Barnabas Medical Center; Richard Shader, PhD, Tufts University.