

The Bowling Green Study of the Primary and Secondary Prevention of Atherosclerotic Disease: Update 1991-1993¹

WILLIAM E. FEEMAN, JR., 640 South Wintergarden Road, Bowling Green, OH 43402

ABSTRACT. This update of the Bowling Green Study (BGS) of the primary and secondary prevention of atherosclerotic disease (ASD) presents additional information to expand the previously published database. Research methodology has not changed. The expanded database now includes the risk factor data for all BGS patients known to have developed some form of clinical ASD from 4 November 1974 to 1 January 1994. The expanded ASD patient database contains data for 267 male and 248 female patients. Plotting the systolic blood pressure (SBP) versus the cholesterol retention fraction (CRF or [LDL-HDL]/LDL, where LDL is low-density lipoprotein cholesterol and HDL is high-density lipoprotein cholesterol) for all ASD patients for whom this information is known revealed that plots for 82% of male and 75% of female patients lie above the ASD threshold line. If only ASD patients less than 80 years of age are considered, then plots for 85% of male and 78% of female ASD patients lie above the ASD threshold line.

Considering patients of any age, those whose plots lie above the ASD threshold line comprise the majority (79%) of ASD patients, with the remainder (21%) of ASD patients lying below the line. The area above the ASD threshold line on the BGS Graph defines the CRF-SBP characteristics for 79% of all ASD patients of any age, and for 82% of all ASD patients less than 80 years of age. Since relatively few ASD patients do not exhibit these CRF-SBP characteristics, it is possible to define the population at risk of clinical ASD as those patients whose plots lie above the ASD threshold line and/or those who smoke cigarettes. Conversely, those people whose plots lie below the ASD threshold line and who never smoked cigarettes appear to have a low risk of developing clinical ASD during their lifetimes.

OHIO J. SCI. 94 (4): 105-112, 1994

INTRODUCTION

The original publication of the Bowling Green Study database (Feeman 1992) presented a table of risk factors for atherosclerotic disease (ASD) of the heart arteries (ASHD), cerebral arteries (ASBD), and peripheral arteries (ASVD) observed between 4 November 1974 to 1 January 1991. In the ensuing three years, additional patients have suffered some form of clinical ASD. Tabulation of the risk factors data of these additional patients would be of interest to those investigators studying the causes of ASD.

MATERIALS AND METHODS

The Bowling Green Study (BGS) of the Primary and Secondary Prevention of Clinical ASD is an ongoing investigation. New patients are added daily to the BGS database, and on a less regular basis to the BGS ASD database. The BGS database consists of a private practice of family medicine in Bowling Green, OH, and all new patients are enrolled in the general database. Those who develop some form of clinical ASD and those new patients who have a history of clinical ASD are added to the BGS ASD database. As a result, the BGS general database (4 Nov 74 - 1 Jan 94) now contains data on 4,758 male and 4,862 female patients, of whom 267 male and 248 female patients have developed some form of clinical ASD. The database of ASD risk factors for those patients who developed clinical ASD prior to 1 January 1991 has been published (Feeman 1992). The database of risk factor data for the 1991-1993 patients are presented in this report (Tables 1-6).

Data collection methods and measurements have not changed since the original publication. Over time, it has been determined that a few ASD patients who were believed to have ASD on the basis of certain electrophysiological or radiological criteria did not actually have ASD. These patients have been deleted from the ASD database (Appendix I and II).

RESULTS

With the addition to the database of information published in this report (Tables 1-6), the BGS ASD database contains risk factor data on 218 male and 220 female patients with ASHD, 94 male and 76 female patients with ASBD, and 52 male and 33 female patients with ASVD. Since some patients have more than one type of ASD, there have been 364 male ASD events and 329 female events. This is an extensive database from which to make projections.

The usefulness of the BGS Graph in predicting the population at risk for ASD is evident (Table 7). If all the patients in the 1974-1993 ASD database are considered, 82% of male ASD patients of all ages and 75% of female ASD patients of all ages lie above the line, regardless of cigarette smoking or diabetes status. If one considers only patients aged less than 80 years, then 85% of male ASD patients and 78% of ASD female patients lie above the ASD threshold line.

Of the patients whose plots lie below the ASD threshold line, 23 are current smokers, 20 are past-smokers, and 21 never-smokers. If only patients aged ≤ 79 years are considered, 21 are current-smokers, 12 are past-smokers, and ten are never-smokers. The earlier BGS report showed that cigarette smoking is second only to the CRF as a risk

¹Manuscript received 15 April 1994 and in revised form 23 August 1994 (=94-08).

TABLE 1

Male ASHD* — 1991-1993.

| Age | ASHD Type | C _T | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-------------|----------------|------|-------|------|-------|-------|-------------|---------|--------|-----|
| 40 | HX | 278 | 32 | 155 | 0.79 | 453 | 67 | past | 126RX | 84RX | 26 |
| 42 | AMI | 221 | 38 | 130 | 0.71 | 264 | 103 | + | 144 | 78 | 31 |
| 42 | AMI | 244 | 40 | 174 | 0.77 | 152 | 78 | + | 138 | 84 | 26 |
| 42 | AMI | 175IH | — | — | — | 109IH | — | + | 140 | 88 | 24 |
| 42 | AMI | 224 | 72 | 135 | 0.47 | 84 | 84 | past | 134 | 80 | 30 |
| 43 | •AP | 231 | 34 | 160 | 0.79 | 185 | 92 | + | 140 | 70 | 24 |
| 43 | AP | 277 | 48 | 216 | 0.78 | 66 | 88 | — | 148 | 88 | 39 |
| 45 | AMI | 238 | — | — | — | 246 | 124D | + | 170 | 90 | 37 |
| 45 | AMI | 254 | 40 | 147 | 0.73 | 336 | 166 | + | 162 | 96 | 31 |
| 45 | •AP | 311 | 42 | 205 | 0.80 | 318 | 300RX | + | 144 | 86 | 28 |
| 46† | AMI | 224 | 35 | 162 | 0.78 | 133 | 525 | + | 132 | 74 | 21 |
| 47 | AP | 329 | — | — | — | 216 | 86 | past | 120 | 78 | 25 |
| 47 | HX | 192IH | 66IH | 108IH | 0.39 | 91IH | — | + | 140RX | 80RX | 24 |
| 48 | UnstableAP | 200 | 22 | — | — | 636 | 126 | — | 126 | 84 | 31 |
| 49 | HX | 152 | 24 | 89 | 0.73 | 195 | 244RX | past | 148RX | 80RX | 43 |
| 50 | +Treadmill | 267 | 38 | 187 | 0.80 | 208 | 122 | + | 118 | 84 | 27 |
| 51 | HX | 200 | 47 | 137 | 0.66 | 94 | 172 | past | 132 | 96 | 30 |
| 53 | AP | 176 | 24 | 114 | 0.79 | 189 | — | — | 122 | 80 | 25 |
| 54 | AMI | 267 | — | — | — | 253 | 79 | chews | 112 | 74 | 26 |
| 55 | AMI | 243 | 38 | 152 | 0.75 | 266 | 158 | + | 122 | 76 | 25 |
| 55 | •+Treadmill | 293 | 52 | 213 | 0.76 | 142 | 54 | past | 126 | 82 | 29 |
| 56† | •HX | 182 | 39 | 115 | 0.66 | 138 | 312RX | + | 128RX | 60RX | 21 |
| 57 | +Treadmill | 260RX | — | — | — | 110RX | 80 | — | 158 | 78 | 29 |
| 58 | AMI | 162 | 27 | 112 | 0.76 | 114 | 92 | + | 162IH | 104IH | 35 |
| 59 | +Treadmill | 209 | — | — | — | 496 | 86 | + | 124 | 80 | 26 |
| 60† | HX | 136IH | — | — | — | — | — | — | 154IH | 108IH | — |
| 62 | HX | 346OL | 38OL | — | — | 580OL | 87 | past cigars | 136 | 84 | 26 |
| 65 | •HX | 193IH | 40IH | 135IH | 0.70 | 90IH | — | + | 134 | 94 | 21 |
| 66† | SUD | — | — | — | — | — | — | + | 168 | 100 | 42 |
| 67 | HX | 256 | — | — | — | 67 | 96 | — | 162 | 90 | 29 |
| 67 | HX | 251 | — | — | — | 390 | 182 | + | 136 | 72 | 26 |
| 67 | CHF | 167 | 37 | 109 | 0.66 | 107 | 137 | past | 128 | 74 | 34 |
| 69† | SUD | — | — | — | — | — | DRX | past | 118RX | 74RX | 28 |
| 70† | •HX | 169IH | — | — | — | — | D | + | 188 | 100 | 28 |
| 70 | HX | — | — | — | — | — | — | + | 134RX | 78RX | 31 |
| 71 | AP | 185 | 38 | 80 | 0.53 | 335 | 156 | past | 112RX | 76RX | 30 |
| 72 | HX | 183 | 32 | 129 | 0.75 | 111 | 92 | + | 122 | 70 | 22 |
| 73 | AMI | 288 | — | — | — | 213 | 162 | past | 132 | 84 | 21 |
| 73† | SUD | — | — | — | — | — | — | past | 132RX | 80RX | 27 |
| 73† | •+Autopsy | — | — | — | — | — | — | — | 174IH | 74IH | — |
| 74 | HX | 179RX | 35RX | 135RX | 0.74 | 45RX | 94 | — | 124 | 72 | 25 |
| 76† | •CHF | 254 | 42 | 188 | 0.78 | 122 | — | past | 140 | 94 | 22 |
| 76 | •+Treadmill | 187 | 39 | 122 | 0.68 | 130 | 355 | past | 128RX | 72RX | 28 |
| 76 | AP | 245 | 31 | 179 | 0.83 | 173 | 131 | past | 170RX | 86RX | 44 |
| 76 | HX | — | — | — | — | — | — | — | 108RX | 60RX | 26 |
| 78† | •CHF | — | — | — | — | — | — | + | 108RX | 62RX | — |
| 79† | SUD | 230 | 47 | 153 | 0.69 | 150 | 111 | past cigars | 170 | 100 | 32 |
| 79 | •AMI | 178RX | 37RX | 124RX | 0.70 | 86RX | — | past cigars | 120IH | 96IH | 22 |
| 81 | CHF | 232 | — | — | — | 113 | 111 | — | 172 | 100 | 27 |
| 82† | •AMI | 165IH | 65IH | 80IH | 0.19 | 100IH | 202IH | + | 136IH | 88IH | — |
| 83† | •HX | 165IH | 24IH | 118IH | 0.80 | 113IH | HXIGT | past | 120RXIH | 70RXIH | — |
| 83 | HX | — | — | — | — | — | — | past | 134RX | 66RX | 31 |
| 83 | HX | 175IH | 34IH | 106IH | 0.68 | 181IH | — | D.past | 202IH | 70IH | — |
| 85 | AP | 210IH | 29IH | 142IH | 0.80 | 192IH | — | — | 162 | 80 | 28 |
| 85 | HX | 226 | 44 | 154 | 0.71 | 142 | — | — | 98 | 56 | — |
| 86† | •CHF | — | — | — | — | — | — | — | 132 | 80 | — |
| 88† | •HX | 179 | 64 | 97 | 0.34 | 90 | — | past | 116 | 74 | 24 |
| 90† | •AP | 248 | 48 | 182 | 0.74 | 91 | 146 | — | 138 | 70 | 26 |

*Abbreviations used in Tables 1-6 are: C_T (total cholesterol), HDL (high-density-lipoprotein cholesterol), LDL (low-density-lipoprotein cholesterol), CRF (Cholesterol Retention Fraction, or LDL-HDL/LDL), TG (triglycerides), PSL (plasma sugar level), SBP (systolic blood pressure), DBP (diastolic blood pressure), BMI (body mass index, or Weight [kg]/Height (m)²), IH (in-hospital data), RX (data after treatment), "D" in the PSL column (known diabetes mellitus), and HXIGT in the PSL column (history of impaired glucose tolerance). The cigarette column abbreviations "+" (current cigarette smoker), past (past cigarette smoker), "-" (never cigarette smoker), A "+" symbol means that the patient has died. A "•" means that the patient has multiple system ASD. AMI (acute myocardial infarction), AP (angina pectoris), CHF (congestive heart failure), HX (history of ASD), and SUD (Sudden Unexpected Death), TCVA (Thrombotic Cerebrovascular Accident), HCVA (Hemorrhagic cerebrovascular accident), TIA (Transient Ischemic Attack), and ACS (asymptomatic carotid stenosis). ASPVD (ASD of the peripheral vasculature), AAA (abdominal aortic aneurysm), TAA (thoracic aortic aneurysm). ASHD means atherosclerotic heart disease, ASBD means atherosclerotic brain disease, and ASVD means atherosclerotic (peripheral) vascular disease.

TABLE 2

*Male ASBD** — 1991-1993.

| Age | ASBD type | C _r | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-----------|----------------|------|-------|------|-------|-------|-------------|---------|--------|-----|
| 16 | TCVA | 147 | 49 | 88 | 0.44 | 50 | 106 | + | 118 | 65 | 17 |
| 39† | HCVA | — | — | — | — | — | — | — | 140 | 90 | 27 |
| 41 | •HX | 231 | 34 | 160 | 0.79 | 185 | 92 | + | 140 | 70 | 24 |
| 42 | HCVA | 199 | 34 | 147 | 0.77 | 91 | 95 | + | 152 | 100 | 24 |
| 45 | •HX | 311 | 42 | 205 | 0.80 | 318 | 300RX | + | 144 | 86 | 28 |
| 49† | •HX | 373 | — | — | — | 118 | — | + | 166 | 104 | 22 |
| 51 | •HX | — | — | — | — | — | —D | + | 102 | 70 | 18 |
| 55 | TIA | 166 | — | — | — | 119 | — | + | 120 | 78 | 20 |
| 55 | •ACS | 293 | 52 | 213 | 0.76 | 142 | 54 | past | 126 | 82 | 29 |
| 57 | •ACS | 193 | 34 | 136 | 0.75 | 116 | 226 | + | 140 | 90 | 27 |
| 57 | ACS | 267 | 33 | 202 | 0.84 | 160 | 86 | + | 136 | 80 | 25 |
| 58 | TIA | 183 | 32 | 100 | 0.68 | 253 | — | past | 118RX | 80RX | 34 |
| 59 | •ACS | 217 | 26 | 143 | 0.82 | 241 | 312 | + | 154RX | 80RX | 30 |
| 63 | •ACS | 245 | 36 | 159 | 0.77 | 252 | 415 | past | 150 | 94 | 29 |
| 63 | •HX | 281 | 48 | 200 | 0.76 | 166 | — | + | 200IH | 86IH | 37 |
| 65 | HX | 209 | 52 | 132 | 0.61 | 124 | 78 | past | 126 | 80 | 23 |
| 65 | •HX | 193IH | 40IH | 135IH | 0.70 | 90IH | — | + | 134 | 94 | 21 |
| 69† | TCVA | 253 | — | — | — | 238 | 76 | + | 152 | 100 | — |
| 70 | HX | — | — | — | — | — | — | past | 160IH | 80IH | — |
| 73† | •TCVA | — | — | — | — | — | — | + | 174IH | 74IH | — |
| 75 | •HX | 314 | 44 | 238 | 0.82 | 160 | 151 | past | 158 | 78 | 27 |
| 76† | •HX | 254 | 42 | 188 | 0.78 | 122 | — | past | 140 | 94 | 22 |
| 76 | •ACS | 187 | 39 | 122 | 0.68 | 130 | 355 | past | 128RX | 72RX | 28 |
| 79† | •HX | — | — | — | — | — | — | + | 108RX | 62RX | — |
| 80 | HCVA | 225 | 62 | 139 | 0.55 | 119 | 138D | cigars | 180 | 100 | 32 |
| 80 | •HX | 245 | 38 | 179 | 0.79 | 142 | 187 | past cigars | 130 | 78 | 25 |
| 80 | •HX | 292 | 47 | 222 | 0.79 | 116 | 97 | — | 164 | 100 | 25 |
| 82† | •HX | 165IH | 65IH | 80IH | 0.19 | 100IH | 202IH | + | 136IH | 88IH | — |
| 83 | •TCVA | 181 | 80 | 88 | 0.10 | 66 | 94 | D.past | 148 | 94 | 27 |
| 83† | •HX | 165IH | 24IH | 118IH | 0.80 | 113IH | HXIGT | past | 120RXIH | 70RXIH | — |
| 86† | TIA | 136IH | 48IH | 71IH | 0.32 | 83IH | — | chews | 150 | 104 | 28 |
| 86 | •ACS | 222 | 46 | 157 | 0.71 | 96 | — | — | 120RX | 80RX | 26 |
| 87† | •TCVA | — | — | — | — | — | — | — | 132 | 80 | — |
| 89† | •HX | 179 | 64 | 97 | 0.34 | 90 | — | past | 116 | 74 | 24 |

*Abbreviations are the same as in Table 1.

TABLE 3

*Male ASVD** — 1991-1993.

| Age | ASVD type | C _r | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-----------|----------------|------|-------|------|-------|-------|-------------|---------|--------|-----|
| 45 | •ASPVD | 311 | 42 | 205 | 0.80 | 318 | 300RX | + | 144 | 86 | 28 |
| 51 | •HX | — | — | — | — | — | D | + | 102 | 70 | 18 |
| 55 | •ASPVD | 293 | 52 | 213 | 0.76 | 142 | 54 | past | 126 | 82 | 29 |
| 59† | •ASPVD | 193 | 26 | 147 | 0.82 | 101 | 107 | + | 124 | 54 | 31 |
| 59 | •ASPVD | 217 | 26 | 143 | 0.82 | 241 | 312 | + | 154RX | 80RX | 30 |
| 63 | •HX | 281 | 48 | 200 | 0.76 | 166 | — | + | 200IH | 86IH | 37 |
| 64 | ASPVD | 257 | 35 | 174 | 0.80 | 239 | 92 | past | 164 | 96 | 24 |
| 67 | •AAA | 206 | — | — | — | 161 | 64 | + | 140 | 72 | 23 |
| 67 | HX | — | — | — | — | — | — | + | 130 | 80 | 28 |
| 73† | •ASPVD | — | — | — | — | — | — | + | 174IH | 74IH | — |
| 79 | •HX | 178RX | 37RX | 124RX | 0.70 | 86RX | — | past cigars | 120IH | 96IH | 22 |
| 81 | •ASPVD | 245 | 38 | 179 | 0.79 | 142 | 187 | past cigars | 130 | 78 | 25 |
| 82† | •AAA | 165IH | 65IH | 80IH | 0.19 | 100IH | 202IH | + | 136IH | 88IH | — |
| 83† | •HX | 165IH | 24IH | 118IH | 0.80 | 113IH | HXIGT | past | 120RXIH | 70RXIH | — |
| 85 | ASPVD | 123IH | 20IH | 77IH | 0.74 | 132IH | 102IH | past chews | 174IH | 82IH | — |

*Abbreviations are the same as in Table 1.

TABLE 4

Female ASHD — 1991-1993.*

| Age | ASHD type | C _r | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-------------|----------------|------|-------|------|-------|-------|------------|---------|---------|-----|
| 41 | AP | 325OL | — | — | — | — | — | + | 136RX | 76RXIH | — |
| 47† | AMI | 293 | 46 | 188 | 0.76 | 293 | 251 | — | 126 | 70 | 37 |
| 50 | HX | 274 | 31 | 215 | 0.86 | 141 | 91 | + | 138 | 74 | 30 |
| 52 | +Treadmill | 212 | 86 | 111 | 0.23 | 77 | 96 | — | 140 | 80 | 28 |
| 53 | •AP | 263RX | 41RX | 195RX | 0.79 | 137RX | 92 | + | 94 | 60 | 21 |
| 55 | •AMI | 352 | 44 | 273 | 0.84 | 173 | 113 | + | 128 | 60 | 15 |
| 55 | HX | 595 | 27 | — | — | 2305 | DRX | past | 122RX | 70RX | 28 |
| 57† | HX | 217 | — | — | — | 137 | 289 | — | 172RX | 100RX | 30 |
| 57 | CHF | 219 | 44 | 132 | 0.67 | 216 | 131D | — | 158 | 92 | 31 |
| 57 | HX | 265IH | 35IH | 197IH | 0.82 | 465IH | D | past | 150 | 76 | 30 |
| 59 | AP | 182 | — | — | — | 118 | 78 | — | 118 | 68 | 28 |
| 59 | CHF | 300 | 39 | — | — | 577 | 106 | + | 138RX | 80RX | 37 |
| 60 | CHF | 279 | 39 | 165 | 0.76 | 377 | 537 | — | 172RX | 136RX | 47 |
| 60† | HX | 241 | 88 | 135 | 0.35 | 91 | 157 | past | 98 | 64 | 15 |
| 60 | HX | 218 | 40 | 150 | 0.73 | 139 | 247RX | — | 164RX | 96RX | 36 |
| 60 | AP | 211 | 38 | 140 | 0.73 | 163 | 100 | — | 140RX | 100RX | 43 |
| 61 | AP | 291 | — | — | — | 169 | 119 | + | 138 | 84 | 41 |
| 62 | •AP | 153 | 32 | 54 | 0.41 | 334 | 372 | D.past | 142 | 90 | 34 |
| 62 | HX | 268 | — | — | — | 128 | 69 | + | 158 | 92 | 21 |
| 62† | SUD | 284 | 52 | 170 | 0.69 | 309 | 200 | + | 180IH | 110IH | 27 |
| 62 | HX | — | — | — | — | — | — | past | 124RX | 80RX | 35 |
| 64 | HX | 284 | 28 | — | — | 624 | 521RX | — | 130 | 80 | 36 |
| 65 | •HX | 187RX | 34RX | 85RX | 0.60 | 338RX | 351RX | + | 132 | 80 | 25 |
| 65 | HX | 231 | 23 | 182 | 0.87 | 131 | 188D | + | 220 | 112 | 46 |
| 66 | •HX | 276 | 36 | 206 | 0.83 | 172 | 106 | — | 160RX | 80RX | 29 |
| 68† | •HX | 258 | 48 | 175 | 0.73 | 176 | 105 | — | 130RX | 72RX | 32 |
| 68 | Unstable AP | 238 | 38 | 156 | 0.76 | 222 | 349RX | past | 192IH | 108IH | 27 |
| 69 | CHF | 273 | 91 | 168 | 0.46 | 72 | — | past | 162 | 80 | 36 |
| 70 | +Treadmill | 276 | 57 | 202 | 0.72 | 104 | 111 | — | 200 | 108 | 24 |
| 70 | HX | 202 | 38 | 127 | 0.70 | 187 | — | — | 140 | 88 | 29 |
| 70 | HX | 282 | 46 | 192 | 0.76 | 218 | 111 | + | 136 | 78 | 39 |
| 71† | AMI | 207 | 64 | 129 | 0.50 | 70 | 115D | past | 200 | 100 | 50 |
| 71† | CHF | 271 | 88 | 167 | 0.47 | 98 | — | past | 120 | 84 | 23 |
| 71 | HX | — | — | — | — | — | — | — | 140RX | 72RX | 23 |
| 73 | •HX | 212 | — | — | — | 150 | 113 | — | 182IH | 94IH | — |
| 73 | HX | 283OL | — | — | — | — | — | + | 130 | 80 | 19 |
| 73 | HX | 309 | 70 | 206 | 0.59 | 164 | 122 | — | 118 | 72 | 27 |
| 74† | SUD | 230 | — | — | — | 191 | 334 | — | 190 | 110 | 35 |
| 75 | •HX | 187 | 65 | 104 | 0.38 | 88 | 78 | — | 156 | 90 | 26 |
| 75 | •CHF | 261IH | 42IH | 194IH | 0.78 | 125IH | — | past | 182IH | 90IH | 30 |
| 75† | •HX | — | — | — | — | — | — | past | 136RXIH | 100RXIH | — |
| 76† | •CHF | 296 | — | — | — | 224 | 75 | + | 102 | 70 | 22 |
| 77 | •AP | — | — | — | — | — | — | + | 138RX | 80RX | — |
| 77 | HX | 321 | 52 | 233 | 0.78 | 182 | 134 | past | 196IH | 96IH | 27 |
| 78 | HX | — | — | — | — | — | —D | — | 122RX | 84RX | 21 |
| 80 | HX | 226 | 39 | 143 | 0.73 | 218 | 195 | + | 146RX | 82RX | 41 |
| 82 | •HX | 275 | 72 | 182 | 0.60 | 107 | 81 | + | 122 | 70 | 24 |
| 83† | HX | 275 | 47 | 164 | 0.71 | 272 | 91 | — | 194 | 118 | 33 |
| 84† | •HX | 184 | 39 | 113 | 0.65 | 162 | — | past | 144RX | 80RX | 22 |
| 85 | HX | 240 | — | — | — | 149 | 82 | D.past | 138 | 78 | 33 |
| 85† | HX | — | — | — | — | — | — | — | 118RX | 76RX | 20 |
| 85 | •CHF | 198IH | 43IH | 109IH | 0.61 | 228IH | — | — | 158 | 90 | — |
| 86† | •AP | 227 | 63 | 125 | 0.50 | 196 | — | past | 132RX | 70RX | 26 |
| 86† | AMI | 228 | 58 | 151 | 0.62 | 94 | 120 | — | 106 | 58 | 27 |
| 88† | HX | — | — | — | — | — | — | — | 124 | 78 | 32 |
| 89 | •HX | 237 | 60 | 141 | 0.57 | 180 | 136 | — | 118RX | 68RX | 24 |
| 89 | •HX | 292 | 47 | 176 | 0.73 | 344 | 89 | — | 124RX | 68RX | 26 |
| 91† | CHF | 180 | 62 | 71 | 0.13 | 235 | — | — | 126 | 80 | 22 |

*Abbreviations are the same as in Table 1.

TABLE 5

Female ASBD — 1991-1993.*

| Age | ASBD type | C ₊ | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-----------|----------------|------|-------|------|-------|-------|------------|-------|-------|-----|
| 52 | •TIA | 153 | 32 | 54 | 0.41 | 334 | 372 | D.past | 142 | 90 | 34 |
| 53 | •TIA | 263RX | 41RX | 195RX | 0.79 | 137RX | 92 | + | 94 | 60 | 21 |
| 65 | •HX | 187RX | 34RX | 85RX | 0.60 | 338RX | 351RX | + | 132 | 70 | 25 |
| 66 | •TIA | 276 | 36 | 206 | 0.83 | 172 | 106 | - | 160RX | 80RX | 29 |
| 67 | TIA | 261 | 39 | 177 | 0.78 | 226 | 299 | - | 130 | 84 | 25 |
| 67 | TCVA | 254 | 40 | 138 | 0.71 | 379 | - | past | 142 | 92 | 23 |
| 68 | •HX | 481 | 43 | 362 | 0.88 | 217 | 78 | - | 168RX | 90RX | 43 |
| 68† | •HX | 258 | 48 | 175 | 0.73 | 176 | 105 | - | 130RX | 72RX | 32 |
| 75 | TIA | 251 | 56 | 174 | 0.68 | 105 | 171D | - | 164 | 90 | 40 |
| 75† | HX | - | - | - | - | - | - | past | 136RX | 100RX | - |
| 76 | HX | 271 | 66 | 185 | 0.64 | 99 | 230 | + | 186 | 112 | 25 |
| 77 | •TCVA | - | - | - | - | - | - | + | 138RX | 80RX | - |
| 78† | •HX | 150IH | 51IH | 86IH | 0.41 | 67IH | D | - | 128 | 80 | - |
| 79 | •HX | 218 | 93 | 99 | 0.06 | 128 | 107 | - | 152 | 94 | 36 |
| 81 | Aneurysm | 228 | 66 | 129 | 0.49 | 163 | 100 | past | 126RX | 84RX | 23 |
| 83 | TCVA | - | - | - | - | - | - | past | 128RX | 88RX | 31 |
| 85 | •TCVA | 187 | 65 | 104 | 0.38 | 88 | 78 | - | 156 | 90 | 26 |
| 85† | •HX | 158 | 52 | 93 | 0.44 | 65 | - | past | 156 | 82 | 30 |
| 85 | •HX | 198IH | 43IH | 109IH | 0.61 | 228IH | - | - | 158 | 90 | - |
| 86† | •HX | 227 | 63 | 125 | 0.50 | 196 | - | past | 132RX | 70RX | 26 |
| 90 | ACS | 275 | - | - | - | 140 | 98 | - | 170 | 88 | 34 |
| 90† | •TCVA | 263 | 51 | 171 | 0.70 | 258 | 255 | - | 168RX | 80RX | 26 |
| 90 | •TCVA | 292 | 47 | 176 | 0.73 | 344 | 89 | - | 124RX | 68RX | 26 |

*Abbreviations are the same as in Table 1.

TABLE 6

Female ASVD — 1991-1993.*

| Age | ASVD type | C ₊ | HDL | LDL | CRF | TG | PSL | Cigarettes | SBP | DBP | BMI |
|-----|-----------|----------------|------|-------|------|-------|-------|------------|-------|------|-----|
| 65 | •HX | 187RX | 34RX | 85RX | 0.60 | 338RX | 351RX | + | 132 | 70 | 25 |
| 72† | •ASPVD | 220 | - | - | - | 160 | 112 | + | 110 | 72 | 22 |
| 73 | •HX | known† | - | - | - | - | - | + | 130 | 80 | 19 |
| 75 | •ASPVD | 261IH | 42IH | 194IH | 0.78 | 125IH | - | past | 182IH | 90IH | 30 |
| 79† | •ASPVD | 268 | 58 | 184 | 0.68 | 132 | - | + | 148RX | 60RX | 20 |
| 82 | •AAA | 275 | 72 | 182 | 0.60 | 107 | 81 | + | 122 | 70 | 24 |
| 83† | •ASPVD | 274 | 67 | 184 | 0.64 | 117 | 92 | - | 138 | 78 | 28 |
| 87† | •HX | 263 | 51 | 171 | 0.70 | 258 | 255 | - | 168RX | 80RX | 26 |
| 88 | •AAA | 261 | - | - | - | 160 | 99 | + | 174 | 78 | 26 |

*Abbreviations are the same as in Table 1.

factor for ASD and can produce ASD even in the absence of a CRF abnormality. If the 43 present/past cigarette smokers whose plots lie below the line are added to the 237 patients whose plots lie above the line (total of 280 patients), then only 21 patients (7%) developed ASD that could not have been predicted by the BGS Graph and ASD threshold line, coupled with knowledge of cigarette smoking history—and 11 (52%) of those 21 patients were 80 years of age or older.

Of the five male never-smoking patients with plots lying below the ASD threshold line, three were hypertensive and one other had lipid values exceeding the CThr.

The younger two hypertensive patients were also diabetic, while the older hypertensive chewed tobacco. Of the 16 female never-smoking patients with plots lying below the ASD threshold line, two had lipid values exceeding the CThr, while eight others were hypertensive. The youngest hypertensive female patient was also diabetic, as was another normotensive normolipidemic patient. Two normotensive, normolipidemic patients had been exposed chronically to cigarette smoke by their chain-smoking husbands. Thus, only one 90 year-old man and four women (aged 86, 89, 91, and 96 years) were free of all ASD risk factors.

TABLE 7

Percent ASD pattern above ASD line – 1974-1993, evaluated by cigarette use.

| Age Group | Cigarette Use | Male | | | Female | | |
|-------------|---------------|-------------------|-------------------|--------------|-------------------|-------------------|--------------|
| | | Number Above Line | Number Below Line | % Above Line | Number Above Line | Number Below Line | % Above Line |
| ≤55 | positive | 25 | 5 | 83 | 5 | 4 | 56 |
| | past | 9 | 1 | 90 | 1 | 2 | 33 |
| | negative | 8 | 1* | 89 | 4 | 2 | 67 |
| | sum | 42 | 7 | 86 | 10 | 8 | 56 |
| 56-65 | positive | 18 | 2 | 90 | 10 | 3** | 77 |
| | past | 10 | 2 | 83 | 4 | 2 | 67 |
| | negative | 0 | 0 | 0 | 8 | 0 | 100 |
| | sum | 28 | 4 | 88 | 22 | 5 | 81 |
| 66-79 | positive | 6 | 3 | 67 | 5 | 4 | 56 |
| | past | 20 | 5 | 80 | 16 | 1 | 94 |
| | negative | 17 | 1 | 94 | 31 | 6 | 84 |
| | sum | 43 | 9 | 83 | 52 | 11 | 83 |
| ≥80 | positive | 0 | 2 | 0 | 1 | 0 | 100 |
| | past | 5 | 3 | 63 | 4 | 4 | 50 |
| | negative | 10 | 3 | 77 | 20 | 8 | 71 |
| | sum | 15 | 8 | 65 | 25 | 12 | 68 |
| Grand Total | | 128 | 28 | | 109 | 36 | |
| Average % | | | | 82 | | | 75 |

*This patient is a 49 year old man with an acute myocardial infarction; he also has chronic persistent hepatitis and his lipid values were taken at the first instance of disease remission. He had frequent relapses and remissions, but the disease at last has gone into complete remission and he is now on medication to correct a low HDL.

**One of the patients has an LDL ≥ 170 mg/dl and hence exceeds the cholesterol threshold, putting her at risk despite her position below the ASD threshold line.

DISCUSSION

Prerequisite to any attempt to reduce the morbidity and mortality caused by ASD is a screening tool that identifies the population at risk of ASD, with high accuracy. Such a screening tool should logically include the major risk factors for ASD. The main ASD risk factors are known to be serum cholesterol, cigarette smoking, and systolic blood pressure (Criqui 1986). This is supported by the BGS database, with the reservation that the cholesterol screening tool should not be the total serum cholesterol but rather the cholesterol retention fraction (CRF or [LDL-HDL]/LDL). The earlier publication (Feeman 1992) demonstrated the superiority of the CRF to the total serum cholesterol. The earlier study also noted the superiority of systolic blood pressure (SBP) over diastolic blood pressure (DBP) in the prediction of ASD.

The previous publication (Feeman 1992) presented the BGS Graph, with the CRF on the ordinant and SBP on the abscissa. The diagonal line represents an empirically-derived line that separates the majority of mainstream BGS ASD-patients from a few outliers who developed relatively mild ASD late in life. The present update expands the published BGS ASD-database and gives the plots for all 301 BGS ASD-patients with CRF and SBP data, all on a single graph.

When the present data are combined with those from Feeman (1992), 79% of all BGS ASD-patient plots lie above the ASD threshold line. Of the 21% of BGS ASD-patients whose plots lie below the ASD threshold line, 67% (43/64) are current or former cigarette smokers. Cigarette smoking is a known major cause of ASD, virtually co-equal with the CRF as a cause of ASD (Feeman 1992). Adjustment for cigarette-smoking status in ASD patients with plots below the ASD threshold line leaves only 7% (21/301) of BGS ASD-patients who could not have been predicted by patient plot location above the line coupled with knowledge of cigarette smoking status. Of these 21 patients, 11 (52%) were 80 years of age or older (Table 7).

The BGS Graph therefore functions as a useful screening tool, when combined with cigarette-smoking status, to define the population at risk of ASD. It utilizes the chief risk factors for ASD and is highly accurate. Its use as a screening tool is therefore recommended.

LITERATURE CITED

- Feeman, W. E. 1992 The Bowling Green study of the primary and secondary prevention of atherosclerosis: Descriptive analysis, findings, applications, and conclusions. *Ohio J. Sci.* 92: 153-181.
- Criqui, M. H. 1986 Epidemiology of atherosclerosis: An updated overview. *Amer. J. Cardiol.* 57: 18C-23C.

APPENDIX I*Alterations of the original database (Feeman 1992).***MALES**

1. Table 6*, 87th patient (plot 0.71 vs 198): The patient is 63 years old, not 64 years old.
2. Table 6, 92nd patient (66 year old with HX): The patient is actually 70 years old.
3. Table 6, 148th patient (plot 0.70 vs 110): The plot used the patient's blood pressure after initiation of therapy. BGS policy is to use pre-treatment (in this case: 120/96IH) blood pressure wherever available.
4. Table 6, 151st patient (plot 0.84 vs 96): The patient is 83 years old, not 81 years old.
5. Table 7, 6th patient (plot 0.82 vs 124): The patient had not quit smoking as he had stated. He should therefore be listed under current cigarette smokers.
6. Table 7, 35th patient (75 year old with ASPVD): The patient has had a PSL value of 182 added. He is also the 23rd patient in Table 8.
7. Table 7, 57th patient (86 year old with TIA): The patient now has had lipid data added: CT = 136IH, HDL = 48IH, LDL = 71IH, CRF = 0.32, TG = 83IH.
8. Table 8, 2nd patient (plot 0.74 vs 110): This 47 year old male had a history of abdominal aortic aneurysm. After detailed investigation, it was determined that the aneurysm was in fact a post-operative complication and not a natural event. His plot has been removed from the BGS Graph for smokers. (At age 49 years, he developed congestive heart failure and will be added back to the ASD database [this time for ASHD] in 1994).

FEMALES

1. Table 9, 17th patient (54 year old with HX): The patient is diabetic and should have a "D" in her PSL data slot.
2. Table 9, 39th patient (plot 0.67 vs 106): This patient complained of atypical symptoms, but a treadmill test was negative. Several years later, another treadmill was ordered, again for atypical symptoms. This time the treadmill was slightly positive. The diagnosis of ASHD was made; however, discussion with a cardiologist revealed that the ASHD label was inappropriate in this scenario and the ASHD diagnosis was abandoned.
3. Table 9, 42nd patient (plot 0.00 vs 160): This patient, on hormone replacement therapy, had a positive treadmill test interpreted by a cardiologist as strongly positive, and the patient refused a recommended coronary angiogram. Her symptoms were atypical for angina. She did agree to a Cardiolute stress test, which was negative. She has had no further symptoms and the ASHD diagnosis has been abandoned.
4. Table 9, 84th patient (plot 0.70 vs 140): The lipid data from an outpatient evaluation is now available. The new values are: CT = 218, HDL = 44, LDL = 143, CRF = 0.69, TG = 154, and PSL = 339.
5. Table 9, 104th patient (75 year old with HX): The patient is now diabetic and should have a "D" placed behind her PSL data.
6. Table 9, 111th patient (plot 0.57 vs 154 RX): The patient's lipids had been modified with drug therapy. An "RX" should therefore be added behind the data in the CT, HDL, LDL, and TG data slots.

7. Table 9, 116th patient (77 year old with ACD): The patient is 78 years old, not 77 years old.
8. Table 9, 118th patient (77 year old with CHF): The patient is 78 years old, not 77 years old.
9. Table 9, 122nd patient (plot 0.41 vs 128): The patient is diabetic and a "D" should be placed in the PSL data slot.
10. Table 9, 126th patient (plot 0.47 vs 174): The patient's blood pressure had already been treated when she presented to the BGS. An "RX" needs to be added to the values in the SBP and DBP slots.
11. Table 9, 163rd patient (90 year old with CHF): The patient should have a PSL datum of 202RX.
12. Table 10, 2nd patient (plot 0.69 vs 180): The SBP and DBP are IH data and an "IH" should be placed behind SBP and DBP values.
13. Table 10, 5th patient (plot 0.31 vs 118): This patient, with a strong family history of stroke and a CAT scan of the brain (again for headaches) showing an old stroke, subsequently had an NMRI scan (again for headaches) which was normal. After discussion with the hospital radiologist, the decision was made that she had not suffered a silent stroke in the past. The diagnosis of ASBD has therefore been abandoned.

*Table numbers refer to tables in the original paper.

APPENDIX II*The following patients from Feeman (1992) died during 1 January 1991 – 1 January 1994 time frame.***MALES**

| MALES | |
|---------------|--------------------|
| Table 6* | |
| 4th patient | (plot 0.71-114) |
| 6th patient | (39 HX) |
| 17th patient | (45 HX) |
| 25th patient | (plot 0.41-94) |
| 30th patient | (39 AMI) |
| 53rd patient | (56 AMI) |
| 68th patient | (plot 0.76-160) |
| 108th patient | (69 AMI) |
| 129th patient | (plot 0.66-168 RX) |
| 154th patient | (82 HX) |
| 162nd patient | (plot 0.46-144) |
| Table 7 | |
| 6th patient | (plot 0.82-124) |
| 26th patient | (plot 0.64-160 RX) |
| Table 8 | |
| 6th patient | (plot 0.71-130) |
| 22nd patient | (75 ASPVD) |

FEMALES

| FEMALES | |
|--------------|-----------------|
| Table 9 | |
| 5th patient | (45 AP) |
| 33rd patient | (59 AP) |
| 47th patient | (63 HX) |
| 68th patient | (plot 0.67-158) |

APPENDIX II (Continued)

| | |
|---------------|--------------------|
| 86th patient | (72 HX) |
| 89th patient | (plot 0.47-136) |
| 96th patient | (plot 0.64-138) |
| 99th patient | (plot 0.68-148) |
| 107th patient | (plot 0.55-210) |
| 110th patient | (plot 0.67-184 RX) |
| 117th patient | (77 CHF) |
| 121st patient | (78 HX) |
| 127th patient | (plot 0.73-118 RX) |
| 143rd patient | (plot 0.44-156) |

| | |
|---------------|-----------------|
| 144th patient | (83 HX) |
| 151st patient | (plot 0.65-168) |
| 154th patient | (plot 0.75-160) |
| 161st patient | (plot 0.56-176) |
| 166th patient | (92 HX) |

Table 10

| | |
|--------------|--------------------|
| 2nd patient | (plot 0.69-180 IH) |
| 19th patient | (plot 0.80-190) |
| 21st patient | (plot 0.74-118 RX) |
| 29th patient | (plot 0.45-144 RX) |

*Table numbers refer to tables in the original paper.

Geography Workshops

Spring 1995

Eastern North America's harsh climate creates a relatively low tree line. You'll study on the Presidential Range of New Hampshire, exploring such topics as snow science, microclimate measurement, vegetation dynamics, winter mammal populations, and avalanche science and safety.

Winter Environments at the Alpine Tree Line

*Dec. 10, 1994, Jan. 6 - 15, Feb. 4, 1995
 4 Undergraduate Credits - \$714
 4 Graduate Credits - \$760
 Special Fee - \$650 (credit)
 Noncredit Fee - \$1,300*

Cultural and Physical Environments of Puerto Rico

*Jan. 3 - 11, 1995
 3 Undergraduate Credits - \$535.50
 3 Graduate Credits - \$570
 Special Fee - \$1,650 (credit)
 Noncredit Fee - \$2,070*

Leave the cold behind this January and experience life in a tropical climate. You'll explore Puerto Rico's unique Spanish cultural heritage and natural wonders on visits to historic forts, old villages, coastal wetland preserves, sugar mills, and sinkholes and caverns.

To register, or for more information, call the College of Continuing Studies at 1-800-672-KSU2.

Sponsored by the Department of Geography through the Office of Public Service and Outreach in the College of Continuing Studies

