THE DETECTION AND MANAGEMENT OF HYPERTENSION IN FAMILY PRACTICE: A PRACTICE AUDIT

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Title:
THE DETECTION AND MANAGEMENT OF HYPERTENSION IN FAMILY PRACTICE: A PRACTICE AUDIT

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EXECUTIVE SUMMARY

1. The prevalence of hypertension in the Stonechurch Family Health Centre (S.F.H.C.) was 18%. This is higher than the prevalence of 15% for Ontario (*p*-value < 0.05).[22] Using logistic regression analysis, *age* was highly significant (*p*-value < 0.0001), while *sex* was not (*p*-value = 0.584). Another 10% had raised B.P. readings. While no patient had hypertension under the age of 30, the prevalence of hypertension rose dramatically to approximately 50% at age 70.

2. 34% of patients with diagnosed hypertension (and receiving medication) were not controlled. This is higher than values reported in other studies (27% & 19%).[32,38]

3. The controlled rate for treated patients *60 and older* (64%) was higher than the rate for untreated patients *60 and older* (22%) (*p*-value = 0.025). In particular, 80% of women *under 60* were controlled compared with 53% for those *60 and older* (higher, *p*-value = 0.046). 88% of the uncontrolled hypertension in the *60 and older* group, was isolated systolic hypertension (I.S.H.). It appears that the clinic did not have a consistent policy for the management of I.S.H. in the elderly. Women were particularly affected.

4. 80% of women *under 60* were controlled, compared to 57% for men *under 60* (higher, *p*-value = 0.108). Strategies for improved surveillance and management are needed for men under the age of 60.

5. The implementation of health maintaining interventions for men appears problematic. 75% of women attended at least once in 1994, compared to only 64% of men (higher, *p*-value < 0.05). Women attended much more (83%) during their child-bearing and child-rearing age. They visited more often, 3.9 visits/year compared to 2.9/year for men (higher, *p*-value < 0.05) During child-rearing age, the rate was 4.7 for women. While women attend for health maintenance (e.g. breast examinations, Pap smears, and contraception), there are no significant gender specific interventions for men.

6. 19% of men never had their B.P. taken, compared to only 8% of women (higher, *p*-value < 0.05). Using logistic regression analysis, both *age* and *sex* were highly significant (*p*-value < 0.0001). In the previous five years, at age 20, 54% of men and 18% of women, did not have their B.P. taken.

7. In the previous year only 44% of the practice had their B.P. taken (within two years: 61%; and five years: 80%). The clinic's 44% coverage for B.P. readings is lower than the 70-75% reported by others.[29,32,33] Dunn reported that 83% of patients who visited their doctor in two years had their B.P. taken.[34]

8. While 82% of Canadians reported visiting a G.P. in the previous year, 70% of the S.F.H.C.'s patients visited in a year.[22] There is a turnover of 84% in two years and 96% in five years. Therefore in general, opportunistic interventions could be run at two or five year cycles (coverage of 84% and 96% respectively).

9. 70% of patients used 100% of the services (visits) in a 1994. 27% of patients accounted for 70% of all visits to the S.F.H.C.

10. Recommendations are made to improve both provider and patient compliance. A Hypertension Flow Chart with accompanying management protocols derived from the *Canadian Consensus on Hypertension Management 1984-1992*, and a *Coronary Artery Disease Risk Prediction Chart*, are provided.[25] It is an accessible up-to-date instrument for consistent and effective management. Family physicians are in the best possible position for on-going population surveillance, opportunistic intervention, early diagnosis, and management of hypertension.

ACKNOWLEDGEMENTS

I am grateful to Dr. R. Viveros-Aguilera for his expertise, kindness, and intellectual rigour. I wish to thank Dr. W.L. Lee for his advice on the clinical aspects of the project and Dr. I.N. Grant for his encouraging support. The project would not be possible without the clinical assessments of the charts by Laurie Panagiotou and Sharon Toreja. I wish to thank Dr. P.D.M. Macdonald and Dr. M.L. Tiku for serving on my examining committee; and the Department of Mathematics and Statistics of McMaster University for a scholarship and a teaching assistantship.

To my father.

PREFACE

Stonechurch Family Health Centre, a McMaster University Family Medical Centre decided to conduct a practice audit to assess its management of hypertension. A mandate of the S.F.H.C. is to implement and monitor strategies for more effective care in light of recent recommendations outlined in *The Canadian Task Force on the Periodic Health Examination.*

The task required considerable assistance from support staff, especially from Debra Twigg, who generated a pre-randomized stratified patient list by age and gender; and from those who extracted and re-filed the hundreds of charts without disrupting patient care. It was therefore more convenient at times for the chart assessors to meet when the clinic was closed. With all this effort, the data was collected in the remarkably short time of two months. The project was an invaluable experience for me to apply my statistical knowledge and skills, and to work collaboratively with physicians with their very special language and idiosyncrasies.

The statistical topics that will be employed throughout this study include: stratified random sampling; multiple linear regression; logistic regression; and 2 x 2 contingency table analysis. The techniques and formulas used for each of these topics can be found in *Appendices B – E.*

I hope the results will be useful to the S.F.H.C. and that the audit methodology will make it easy for similar audits to follow.

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INTRODUCTION

Hypertension is the most important medical condition for physicians concerned with health maintenance. It is a major contributor to cardiovascular disease, which is the prime cause of death (40%) in Canada.[1] Most often a silent, insidious, and slowly progressive disease, hypertension may announce its presence in a catastrophic manner, such as a stroke, heart failure, ruptured aortic aneurysm, myocardial infarction and occlusive peripheral vascular disease.[2] Conclusive evidence attests to the efficacy of early detection and treatment in reducing disease progression, morbidity and mortality.[3-15]

In Canada, 15% of the adult population (men 16%; women 13%) have hypertension and an almost equal percentage have elevated blood pressure on some, if not all, occasions.[16] Mild hypertension is a powerful predictor of progression to more severe elevations.[17] A prospective study of 20-39 year old men, over a 30-year period demonstrated that a casual elevated blood pressure reading on one occasion correlates significantly with elevated blood pressure in later life.[18,19] The control of hypertension appears to be problematic when only 42% of hypertensives were treated and controlled (16% were treated and not controlled; 16% were not treated and not controlled and a further 26% were unaware that they had hypertension).[16] Hence, a total of 58% of the hypertensives had uncontrolled hypertension.

Mass screening programmes (e.g. in shopping malls) are ineffective. Even when well-organized, such programmes reach less than 10% of the population.[20] Such screening programmes are subject to volunteer bias whereby the more motivated and health conscious (and perhaps healthier) are more likely to attend. Volunteers for screening are generally a strange and healthy lot, and we cannot generalize from them to our other patients.[21] On the other hand, general practitioners are in an ideal position to conduct blood pressure screening, when 82% of Canadians visit a general practitioner (G.P.) in a 12 month period.[22] Also a G.P. has a 95% turnover of practice patients in 5 years.[23]

SECTION A: METHODS

1. The Site

Stonechurch Family Health Centre (S.F.H.C.) is a community-based, academic family practice situated near the southern boundary of the city of Hamilton, Ontario. S.F.H.C. has a complement of five faculty (family) physicians, two nurse practitioners, a social worker, a psychiatrist, and sixteen family medicine residents, four of whom are full-time at the centre at any time. S.F.H.C. has about 4,000 registered patients. It is a Health Service Organization which receives payment for health services per capita, based on the number, age and gender of its patient roster. S.F.H.C. provides comprehensive primary care and emphasizes health promotion.

2. Objectives of the Audit

The objectives of the audit are to evaluate the Centre's clinical effectiveness in the early detection and management of hypertension, and to recommend changes to improve effectiveness.

3. Questions to be Answered by the Audit

The clinicians derived a number of questions to be answered by the audit:

1. What % of the practice is seen in 1 year?
2. How often is the blood pressure recorded?
3. What is the prevalence of hypertension?
4. How does it relate to age?
5. How many different care givers are seen by a patient?
6. What % of hypertensive patients were treated?
7. Was the hypertension well-controlled?
8. Was inquiry and or tests made for target organ damage?
9. How compliant are patients with medications?

4. Sample Planning

The life-time prevalence of hypertension (HTN) in Ontario is 15%.[22] The age/sex patient distribution is derived in 5 year increments. The population of interest is age 20 years and over, which represents about 75% of the practice, or around 3000 patients.

Total Population	3,000
Sample 1-in-5	600
HTN Prevalence	15%
Expected HTN Pts.	90

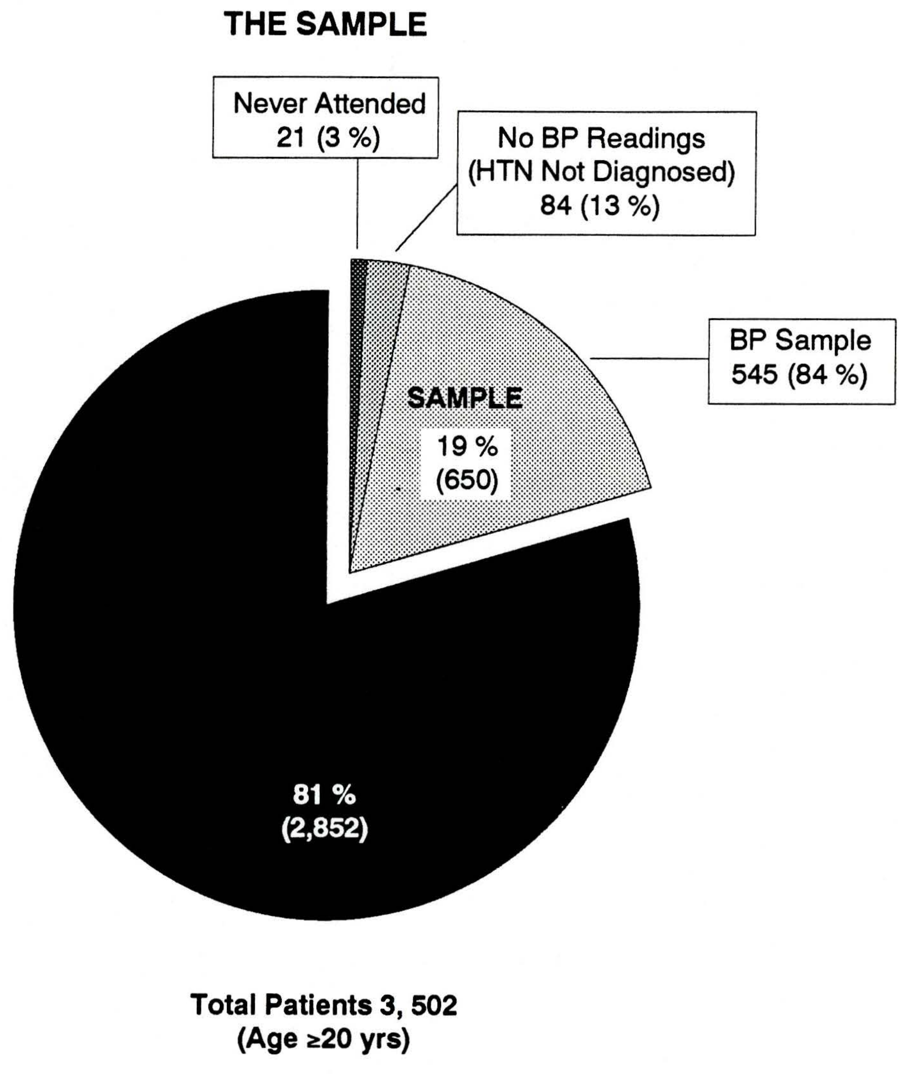
Thus, a 1-in-5 sample of 600 charts, with an estimated hypertension prevalence of 15%, would yield around 90 hypertensive patient charts for analysis.

5. Sampling Method

Each patient was successively assigned a chart number when the patient first enrolled at the health centre. A computerized patient list (as of November 22, 1994) was generated by chart number, and stratified by gender and by age (20-24; 25-29;...; 75+). This chart list was used as the sampling frame for this study. The sample can be considered as a stratified random sample without replacement with a simple random sample from each strata (*Appendix B*). Systematic sampling was used, as there is no apparent trend, correlation, or periodicity in the generated list. A random 1-in-5 systematic sample was drawn from each age/sex stratum, starting from the second chart in each stratum.

- The total patient population (≥ 20 yrs.) was 3,502 (see Fig. 1).
- The sample size was 650 (19% of patients).
- In the sample, 21 patients were enrolled in the practice but had never yet been seen.
- The remaining 629 charts were reviewed for general information, e.g. % practice seen in a year; the number of different care-givers; and blood pressure recording.
- A further 84 patients never had their blood pressure recorded.
- The remaining 545 charts (84% of the sample) were reviewed for hypertension prevalence.
- The charts of patients with diagnosed hypertension (n =100) were reviewed for evaluation of clinical effectiveness.

Fig. 1.


THE SAMPLE
Never Attended
21 (3 %)
No BP Readings
(HTN Not Diagnosed)
84 (13 %)
BP Sample
545 (84 %)
SAMPLE
19 %
(650)
81 %
(2,852)
Total Patients 3, 502
(Age ≥20 yrs)

6. Chart Audit Questionnaire

The audit questionnaire was designed from the questions derived from the Health Centre's physicians. Guidelines for effective detection and management of hypertension were derived from *The Canadian Consensus on Hypertension Management 1984-1992* [25] and were incorporated into the questionnaire. A sample is enclosed in *Appendix A*.

7. Categorical Criteria

- **High Blood Pressure:**
  High blood pressure (B.P.) is indicated when both B.P. readings are ≥ 140/90.

- **Hypertension** (HTN):
  A patient is declared hypertensive if the condition is diagnosed and indicated in the chart (*treated & untreated;* and *controlled & uncontrolled*).

- **Elevated B.P.** (E.B.P.):
  A patient is said to have E.B.P. if they have ***high B.P.*** or *diagnosed HTN.*

- **Target Organ Damage** (T.O.D.):
  The presence of any: - history of angina pectoris
  - evidence of myocardial infarction
  - electrocardiograph with left ventricular hypertrophy
  - stroke/transient ischaemic attack
  - intermittent claudication
  - serum creatinine > 150 μmol/L
  - thoracic or abdominal aneurysm in the elderly

- **Controlled B.P.:** (note: S.B.P.: systolic B.P.; D.B.P.: diastolic B.P.)
  The condition (diagnosed HTN) is deemed controlled if:
  Patients < 60 years old: - No T.O.D. & the D.B.P. < 100 *or*
  - T.O.D. & the D.B.P. < 90
  Patients ≥ 60 years old: - D.B.P. < 105 & S.B.P. < 160

- ***Good* Compliance:**
  Compliance is judged from the appropriateness of the dates and/or quantities of medication renewal; chart notations about good or bad compliance; or missed appointments and poor follow-up.

8. Clinical Assessment of Patient Records

The clinical records of patients (from the sample) were reviewed during January–March, 1995. Data was drawn from chart entries up to and including December 31, 1994. The *previous year* refers to data from the calender year 1994. Together, a team of one nurse, a physician and the investigator critically reviewed a set of charts each and consulted each other over the interpretation of chart notes.

9. Data Recording

The data from the questionnaire were incorporated into an ASCII data file via *MINITAB Release 10 for Windows.*

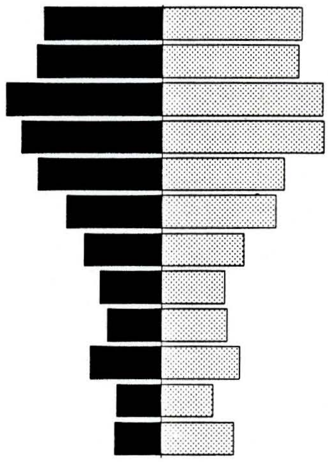
10. Manipulating and Analyzing the Data

MINITAB Release 10 for Windows was extremely useful in the data analysis. The *MINITAB* functions that were used extensively are: *tally* for counts; *describe* for basic summary statistics; and *regress* for curve fitting. *GLMStat* was used for the logistic regression analysis, as well as for multiple linear regression.

Statistical methods that were used throughout this study include: stratified random sampling; multiple linear regression; logistic regression; and 2 x 2 contingency table analysis. The techniques and formulas used for each of these methods are described in the *Appendix B – E*. Data sets are included in *Appendix F*.

Fig 2.1

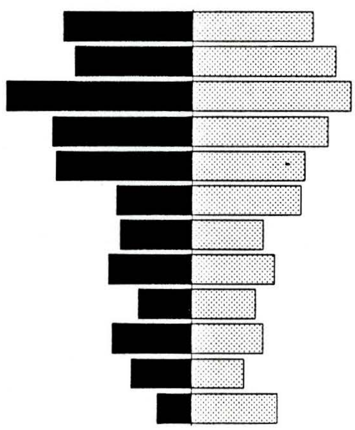
SFHC PATIENT ROSTER: 20 YRS AND OVER



Age Group	M	%	%	F	Total	%
20 – 24	175	-5.00%	5.91%	207	382	10.91%
25 – 29	185	-5.28%	5.77%	202	387	11.05%
30 – 34	230	-6.57%	6.80%	238	468	13.36%
35 – 39	208	-5.94%	6.85%	240	448	12.79%
40 – 44	183	-5.23%	5.20%	182	365	10.42%
45 – 49	141	-4.03%	4.85%	170	311	8.88%
50 – 54	114	-3.26%	3.51%	123	237	6.77%
55 – 59	91	-2.60%	2.68%	94	185	5.28%
60 – 64	80	-2.28%	2.80%	98	178	5.08%
65 – 69	105	-3.00%	3.34%	117	222	6.34%
70 – 74	66	-1.88%	2.20%	77	143	4.08%
75+	68	-1.94%	3.08%	108	176	5.03%
TOTAL	1646	47%	53%	1856	3502	100.00%

Fig 2.2

AUDIT STRATIFIED SAMPLE:20 YRS AND OVER

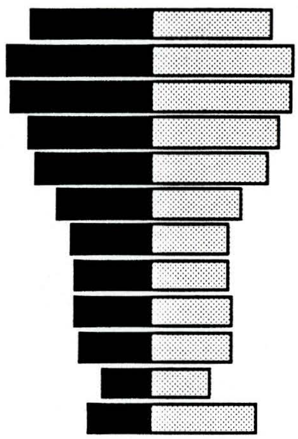


Age Group	M	%	%	F	Total	%
20 – 24	34	-5.41%	5.09%	32	66	10.49%
25 – 29	31	-4.93%	6.04%	38	69	10.97%
30 – 34	49	7.79%	6.68%	42	91	14.47%
35 – 39	37	-5.88%	5.72%	36	73	11.61%
40 – 44	36	-5.72%	4.77%	30	66	10.49%
45 – 49	20	-3.18%	4.61%	29	49	7.79%
50 – 54	19	-3.02%	3.02%	19	38	6.04%
55 – 59	22	-3.50%	3.50%	22	44	7.00%
60 – 64	14	-2.23%	2.70%	17	31	4.93%
65 – 69	21	-3.34%	3.02%	19	40	6.36%
70 – 74	16	-2.54%	2.23%	14	30	4.77%
75+	9	-1.43%	3.66%	23	32	5.09%
TOTAL	308	49%	51%	321	629	100.00%

Fig. 3.1

POPULATION HAMILTON-WENWORTH 1991

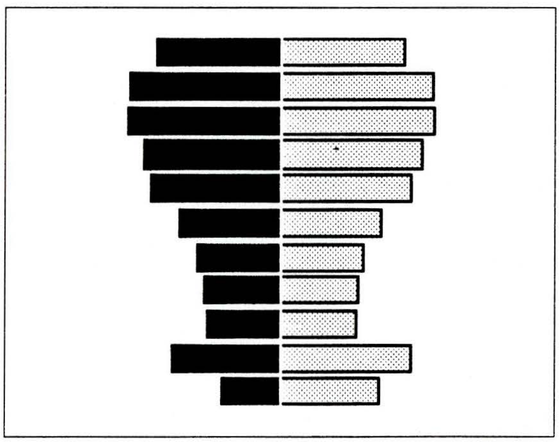
20 YEARS AND OVER



Age Group	M	%	%	F	Total	%
20 – 24	16815	-5.04%	5.11%	17055	33870	10%
25 – 29	20120	-6.03%	5.99%	19995	40115	12%
30 – 34	19610	-5.87%	5.96%	19890	39500	12%
35 – 39	17200	-5.15%	5.44%	18165	35365	11%
40 – 44	16090	-4.82%	4.96%	16575	32665	10%
45 – 49	13050	-3.91%	3.86%	12880	25930	8%
50 – 54	11060	-3.31%	3.31%	11055	22115	7%
55 – 59	10645	-3.19%	3.29%	11000	21645	6%
60 – 64	10665	-3.19%	3.45%	11530	22195	7%
65 – 69	9865	-2.95%	3.50%	11700	21565	6%
70 – 74	6595	-1.98%	2.55%	8500	15095	5%
75+	8655	-2.59%	4.54%	15145	23800	7%
TOTAL	160370	48%	52%	173490	333860	100%

Fig. 3.2

ONTARIO POPULATION 1991: 20 YRS AND OVER



Age Group	M	%	%	F	Total	%
20 – 24	370570	-5.04%	5.04%	370525	741095	10%
25 – 29	449265	-6.11%	6.20%	455730	904995	12%
30 – 34	452190	-6.15%	6.29%	462665	914855	12%
35 – 39	405085	-5.51%	5.73%	421390	826475	11%
40 – 44	382390	-5.20%	5.30%	389500	771890	11%
45 – 49	301520	-4.10%	4.09%	300595	602115	8%
50 – 54	248565	-3.38%	3.38%	248625	497190	7%
55 – 59	228850	-3.11%	3.16%	232170	461020	6%
60 – 64	218390	-2.97%	3.12%	229085	447475	6%
65 – 74	320015	-4.35%	5.35%	393585	713600	10%
75+	173335	-2.36%	4.03%	296535	469870	6%
TOTAL	3550175	48.30%	51.70%	3800405	7350580	100%

SECTION B: RESULTS

1. Age/Sex Composition of the Sample

The adult (≥ 20) age/sex composition of the sample and of the total clinic population, were similar. The clinic population was slightly younger than the population of Hamilton-Wentworth region and the province of Ontario.[26,27]

Population (≥ 20 yrs.)	50-64 yrs.	≥ 65 yrs.
S.F.H.C.	17%	15%
Hamilton-Wentworth	20%	18%
Ontario	19%	16%

The age/sex compositions are illustrated in Figures 2 and 3. Note: In Figure 3.2, age groups 65-69 & 70-74 were combined at the source.

2. Patient Visits

2.1 Proportion of Patients Seen

2.1.1 Proportion Seen in 1 Year

The data in Table 1 refer to the number of people who came at least once to the clinic in 1994. The data is stratified by *age group* and *sex*.

Table 1. The Number of Patients Seen in 1 Year (1994)

group	sex	seen in '94	sample size	stratum size
20-24	M	20	34	175
25-29	M	20	31	185
30-34	M	28	49	230
35-39	M	19	37	208
40-44	M	20	36	183
45-49	M	15	20	141
50-54	M	14	19	114
55-59	M	13	22	91
60-64	M	11	14	80
65-69	M	17	21	105
70-74	M	14	16	66
75+	M	7	9	68
20-24	F	22	32	207
25-29	F	31	38	202
30-34	F	35	42	238
35-39	F	25	36	240
40-44	F	18	30	182
45-49	F	21	29	170
50-54	F	13	19	123
55-59	F	16	22	94
60-64	F	12	17	98
65-69	F	18	19	117
70-74	F	10	14	77
75+	F	21	23	108

The counts, sample size, and stratum size are provided and the proportions calculated. The estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.6995 +/- 0.0324
proportion (men):	0.6429 +/- 0.0484
proportion (women):	0.7539 +/- 0.0436

The proportion of women seen at least once in the last year (1994) is higher for men than women. A point estimate for the risk difference is 0.1110, and a 95% C.I. for the true risk difference is [0.0459, 0.1762]. Since the C.I. does not contain 0, it can be concluded that the proportion of women who came to the clinic in the last year **is significantly higher** than the same proportion for men. The results are displayed in Figure 4.

2.1.2 Proportion Seen in 2 Years

The data in Table 2 refer to the number of people who came at least once to the clinic in a two year interval (1993-1994). The data is stratified by *age group* and *sex*.

Table 2. The Number of Patients Seen in 2 Years (1993 or 1994)

group	sex	seen in 2 yrs.	sample size	strata size
20-24	M	25	34	175
25-29	M	24	31	185
30-34	M	33	49	230
35-39	M	29	37	208
40-44	M	28	36	183
45-49	M	16	20	141
50-54	M	16	19	114
55-59	M	16	22	91
60-64	M	14	14	80
65-69	M	19	21	105
70-74	M	14	16	66
75+	M	7	9	68
20-24	F	26	32	207
25-29	F	35	38	202
30-34	F	38	42	238
35-39	F	33	36	240
40-44	F	25	30	182
45-49	F	25	29	170
50-54	F	18	19	123
55-59	F	19	22	94
60-64	F	16	17	98
65-69	F	18	19	117
70-74	F	12	14	77
75+	F	22	23	108

Similarly, the estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.8394 +/- 0.0257
proportion (men):	0.7825 +/- 0.0418
proportion (women):	0.8941 +/- 0.0313

The proportion of women seen at least once in the last two years is higher for men than women. A point estimate for the risk difference is 0.1116, and a 95% C.I. for the true risk difference is [0.0594, 0.1639]. Since the C.I. does not contain 0, it can be concluded that the proportion of women who came to the clinic at least once in the last 2 years **is significantly higher** than the same proportion for men. The results are displayed in Figure 4. Figure 4 illustrates that at different time intervals, a greater proportion of women visit the clinic.

2.1.3 Proportion Seen in the Last 5 Years

The data in Table 3 refer to the number of people who came at least once to the clinic in a five year interval (1990-1994). The data is stratified by *age group* and *sex.*

Table 3. The Number of Patients Seen in 5 Years (1990-1994)

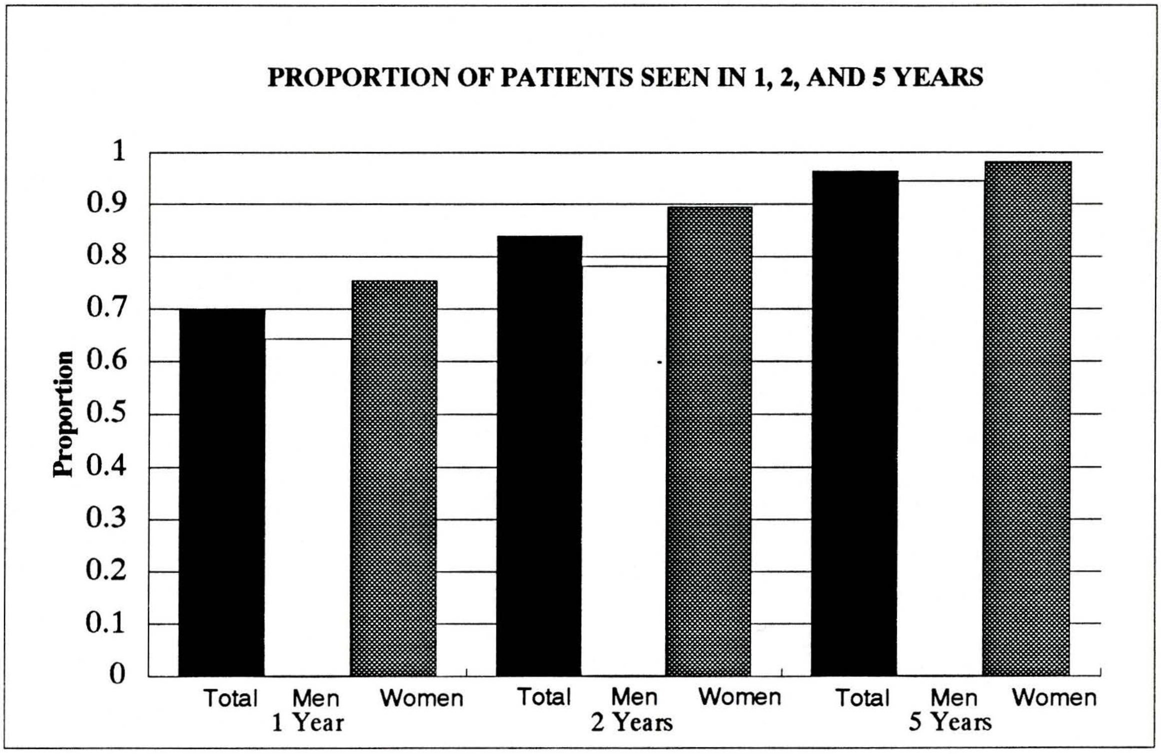
group	sex	seen in 5 yrs.	sample size	strata size
20-24	M	33	34	175
25-29	M	30	31	185
30-34	M	45	49	230
35-39	M	35	37	208
40-44	M	33	36	183
45-49	M	19	20	141
50-54	M	17	19	114
55-59	M	20	22	91
60-64	M	14	14	80
65-69	M	20	21	105
70-74	M	16	16	66
75+	M	9	9	68
20-24	F	32	32	207
25-29	F	37	38	202
30-34	F	41	42	238
35-39	F	35	36	240
40-44	F	30	30	182
45-49	F	29	29	170
50-54	F	18	19	123
55-59	F	22	22	94
60-64	F	17	17	98
65-69	F	18	19	117
70-74	F	14	14	77
75+	F	22	23	108

The estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.9634 +/- 0.0130
proportion (men):	0.9448 +/- 0.0229
proportion (women):	0.9813 +/- 0.0138

The proportion of women seen at least once in the last five years (1990-1994) is higher for men than women. A point estimate for the risk difference is 0.0365, and a 95% C.I. for the true risk difference is [0.0098, 0.0632]. Since the C.I. does not contain 0, it can be concluded that the proportion of women who came to the clinic at least once in the last 5 years **is significantly higher** than the same proportion for men. The results are also displayed in Figure 4.

Fig. 4


PROPORTION OF PATIENTS SEEN IN 1, 2, AND 5 YEARS
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Total
Men
Women
1 Year
Total
Men
Women
2 Years
Total
Men
Women
5 Years

2.1.4 The Cumulative Practice Proportion Seen 1 Year

Table 4 provides the data for the cumulative proportion of the practice seen in one year (1994). Figure 5 displays the data.

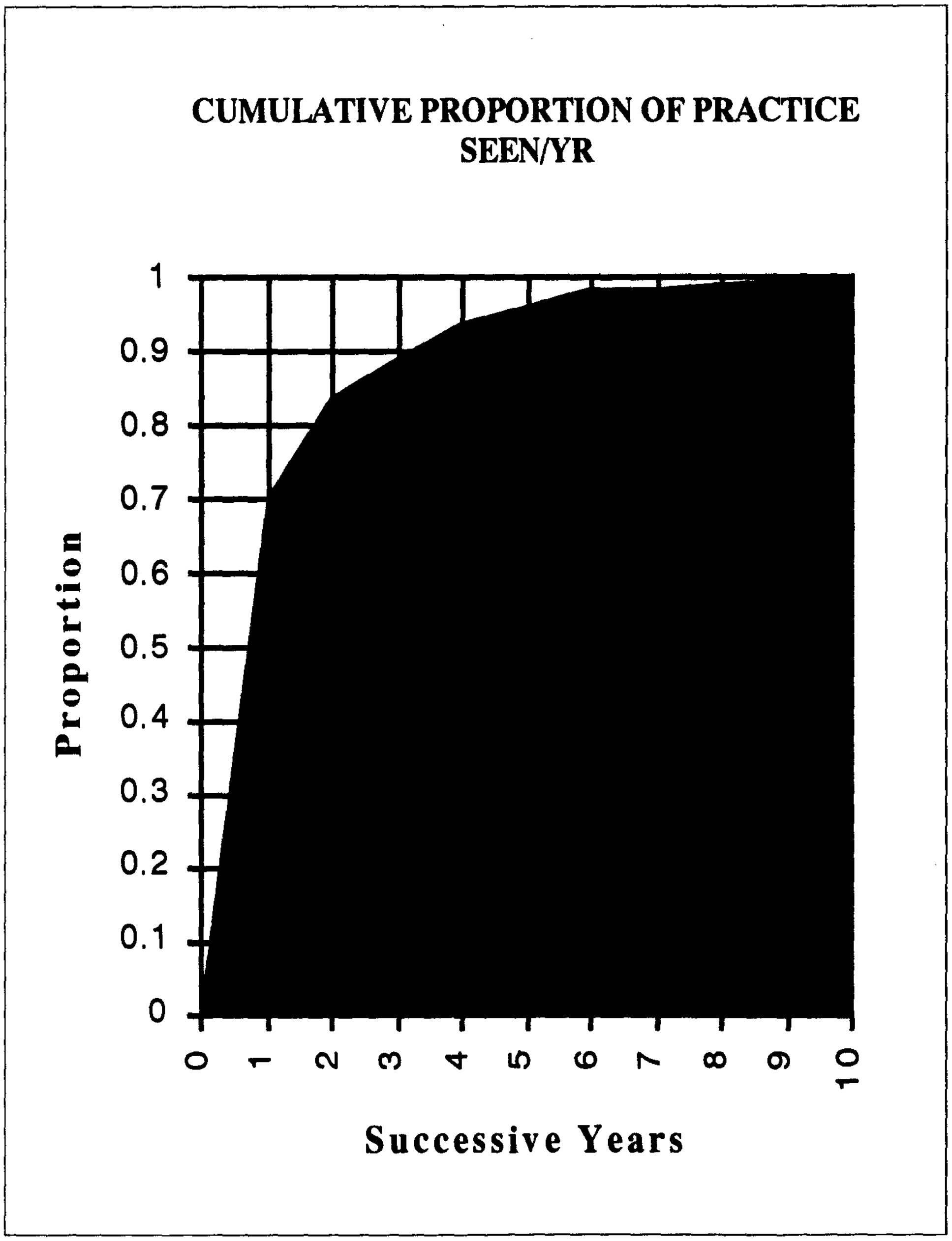
Table 4. The Cumulative % of Practice Seen / Year

year	# last seen	% total	cum. %
0	0	0	0
1	440	69.95%	69.95%
2	88	13.99%	83.94%
3	33	5.25%	89.19%
4	29	4.61%	93.80%
5	16	2.54%	96.34%
6	12	1.91%	98.25%
7	3	0.48%	98.73%
8	3	0.48%	99.21%
9	1	0.16%	99.36%
10	1	0.16%	99.52%
11	1	0.16%	99.68%
12	0	0.00%	99.68%
13	0	0.00%	99.68%
14	1	0.16%	99.84%
15	1	0.16%	100.00%
Total	629	100%	

From Figure 5, close to 70% of the practice is seen in a period of one year; 90% in three years; and 96% in five years. Similar percentages were reported in 1973 for Canada.[28] However in 1991, 82% Canadians contacted a G.P. in the previous year.[22] In 1990, 81% of Ontario residents saw a G.P. at least once.[29]

The rate of turnover of the practice population is significant when considering opportunistic screening interventions. While it has been recommended that the simple and quick procedure of taking a blood pressure be done at every visit, for all adults, few G.P.s do this. Only 23% of Toronto physicians reported measuring the B.P. of middle-aged patients at every visit.[30] Bass argues that even if the procedure takes a minute, for 30 patients it would add another 30 minutes to a busy G.P.'s day. Furthermore, visits are not evenly distributed among patients but are skewed towards the heavier users. He suggests that screening every two years (or at least every five years) is more attainable, when, as in this clinic, over 95% of the practice will be seen.[23] This approach is consistent with the slowly progressive nature of hypertension.

Fig. 5



CUMULATIVE PROPORTION OF PRACTICE SEEN/YR
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
8
9
10
Successive Years

2.1.5 Proportion of Patients Seen in 1 Year: by age and sex

The data in Table 5 refer to the number of people who came at least once to the clinic in 1994, out of the total sample. The data is stratified by *age group* and *sex*.

Table 5. The Number of Patients Seen At Least Once in Last Year (1994)

age group	average age	sex	seen at least once in 1994	total (sample)
20-24	22.618	M	20	34
25-29	26.935	M	20	31
30-34	31.592	M	28	49
35-39	36.703	M	19	37
40-44	42.361	M	20	36
45-49	46.650	M	15	20
50-54	51.947	M	14	19
55-59	56.682	M	13	22
60-64	62.357	M	11	14
65-69	66.905	M	17	21
70-74	71.687	M	14	16
75+	77.330	M	7	9
20-24	22.156	F	22	32
25-29	27.263	F	31	38
30-34	31.952	F	35	42
35-39	37.139	F	25	36
40-44	41.633	F	18	30
45-49	46.862	F	21	29
50-54	52.158	F	13	19
55-59	57.500	F	16	22
60-64	62.235	F	12	17
65-69	66.737	F	18	19
70-74	71.143	F	10	14
75+	80.570	F	21	23

The linear logistic model is used to analyze the relationship between the proportion of patients who came to the clinic at least once in the last year (the dependent variable), and the independent variables of *age* and *sex*. The deviances (and reduction in deviance) on fitting each of the successive models follow, where *sex* is fitted first.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	43.16	23		
const., sex	33.91	22	9.246	1
const., sex, age	25.27	21	8.649	1
const., sex, age, sex.age	23.71	20	1.559	1

The model with only the constant term has an overall deviance of 43.16 (23 d.f.). There is a significant lack of fit as the *p*-value = 0.0066. When *sex* is fitted, the reduction in deviance is 9.246 (1 d.f.) which is highly significant (*p*-value = 0.0024). The reduction in deviance is 8.649 (1 d.f.) when *age* is fitted, which is also highly significant (*p*-value =

0.0033). The interaction effect is not significant, because the reduction in deviance is only 1.559 (1 d.f.), with a ***p***-value of 0.2118. Thus, when *sex* is fitted first, the main effects of *sex* and *age* are both significant. Similar results are obtained when *age* is fitted first.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	43.16	23		
const., age	33.73	22	9.428	1
const., age, sex	25.27	21	8.468	1
const., age, sex, sex.age	23.71	20	1.559	1

The overall deviance when only the main effects are fitted is 25.27 (21 d.f.), which indicates a good fit (as the lack of fit is not significant: ***p***-value = 0.2357). The simplest model with a good fit would only include the main effects of *age* and *sex*.

As *sex* is significant, separate linear logistic models are constructed for both men and women. The parameter estimates for the linear logistic model where the proportion of ***men*** who came to the clinic in the last year are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	*p*-value
constant	-0.3904	0.3532	-1.105	0.2690
age	0.02308	0.008008	2.883	0.0039

Since the Wald ratio for the constant term is not significant (***p***-value = 0.2690), the constant term can be dropped. The estimate for this simplified model is as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	*p*-value
age	0.01483	0.002689	5.514	<0.0001

Similarly, the parameter estimates for ***women*** are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	*p*-value
constant	0.7117	0.3614	1.969	0.0489
age	0.009193	0.007721	1.191	0.2338

The Wald ratio for *sex* is not significant (*p*-value = 0.2338), thus *sex* is insignificant in explaining the data. *Sex* can be dropped, and the estimate for this simplified model is:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	1.119	0.1295	8.642	<0.0001

The equations for the fitted probabilities for men and women are:

$$\hat{p}_{\textit{Seen at least once in 1994: Men}} = \frac{\exp(0.01483 age)}{1+\exp(0.01483 age)}$$

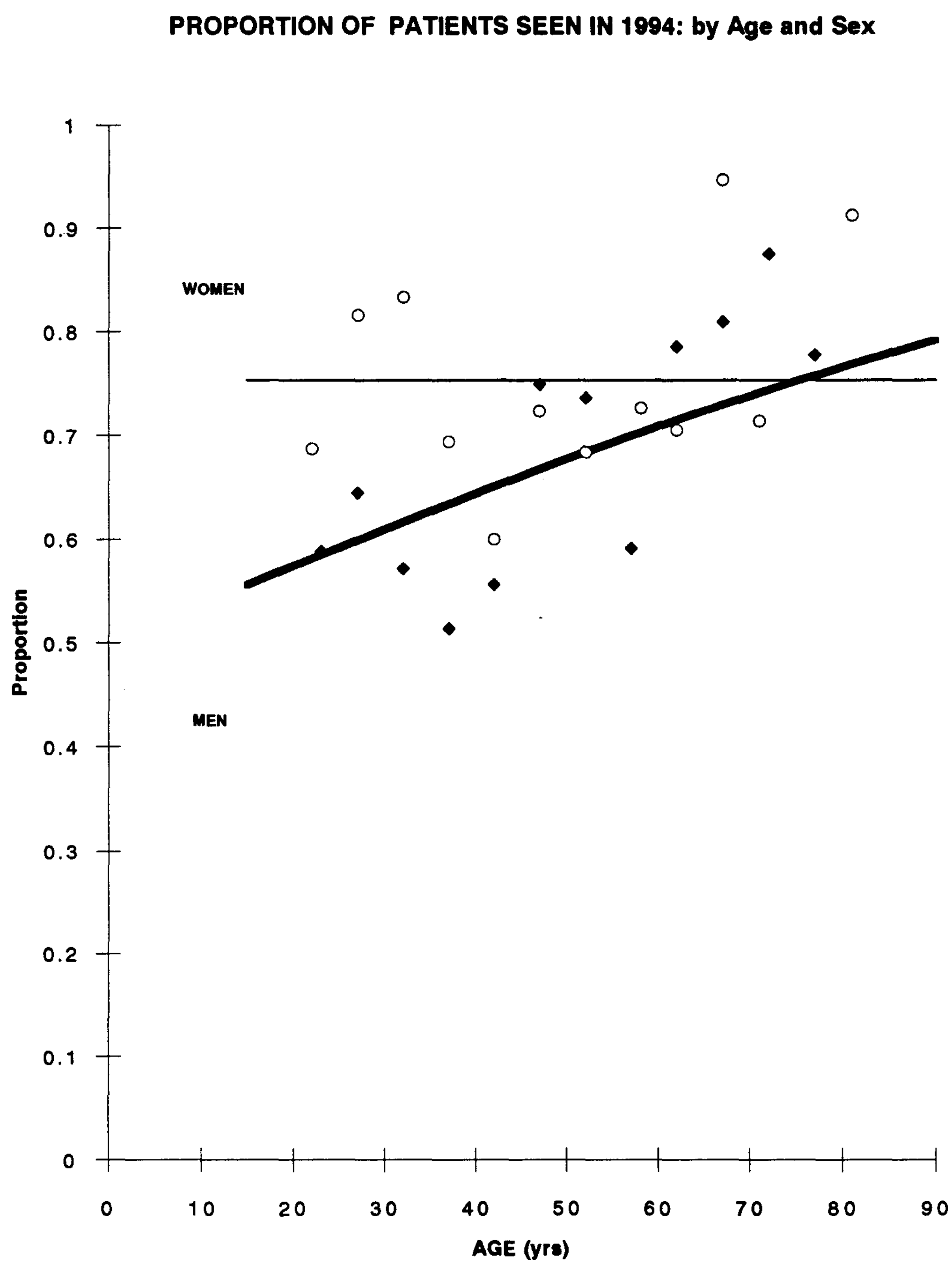
$$\hat{p}_{\textit{Seen at least once in 1994: Women}} = \frac{\exp(1.119)}{1+\exp(1.119)} = 0.7538$$

Figure 6 displays the two linear logistic models for men and women, as well as the observed values. At any age group, an estimated 75% of women attend the clinic. There are however two peaks of greater proportions: 0.83 for age group 30-34 and 0.95 for the age group 65-69. For men, there is a gradual and steady increase from a low of under 60% at age 20, to approximately 75% at age 74. The early peak for women coincides with their child-bearing and child-rearing period. That a greater proportion of women than men are seen, reflects current health promotion programmes which are not available for men.

Women have been especially targeted for health promotion (e.g. the well-woman examination). Gender specific visits are for Pap smears, breast examination, contraceptive advice, pregnancy, menstruation and for menopause. Pregnancy calls for more frequent visits. Mothers also regularly attend with their infants and may be seen at the same time. They become more familiar with services provided by the clinic and might use them more. These results are specific to family practice; one might expect a different gender orientation for emergency departments, where work-related trauma might cause more visits by men.

It is interesting to note that for women, there is an increasing trend with respect to *age*. As can be seen from Figure 6 however, there is a large variation in the data. So much so that the *age* parameter is not significantly different from 0 (*p*-value = 0.2338). Thus *age* for women is not significant.

Fig. 6.


PROPORTION OF PATIENTS SEEN IN 1994: by Age and Sex
WOMEN
MEN
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
AGE (yrs)

2.2 The Average Number of Patients Seen

2.2.1 Average Visits: by sex

Table 6. The Average Number of Visits/Patient in 1 Year (1994)

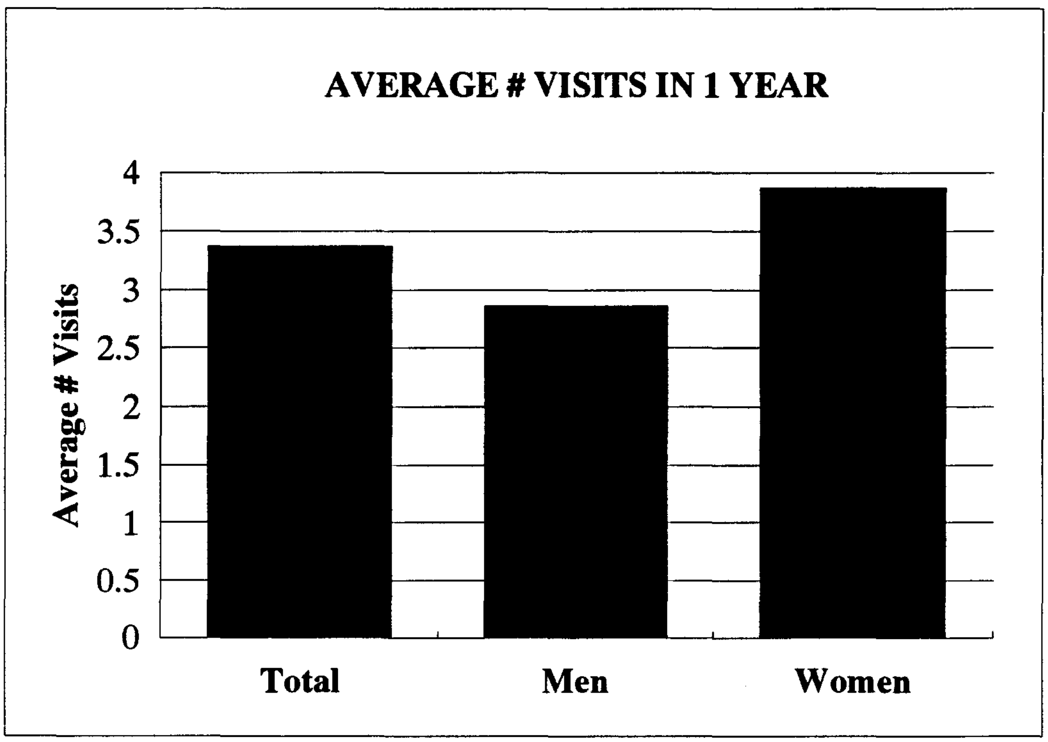
age group	sex	ave. # visits	sample size	stratum size	s
20-24	M	1.500	34	175	1.796
25-29	M	2.387	31	185	4.551
30-34	M	2.020	49	230	2.869
35-39	M	1.676	37	208	2.678
40-44	M	1.944	36	183	2.693
45-49	M	2.800	20	141	3.019
50-54	M	3.000	19	114	3.333
55-59	M	3.550	22	91	4.860
60-64	M	5.930	14	80	4.430
65-69	M	4.619	21	105	3.598
70-74	M	5.687	16	66	3.825
75+	M	7.000	9	68	8.530
20-24	F	2.812	32	207	4.223
25-29	F	4.658	38	202	4.966
30-34	F	4.357	42	238	4.265
35-39	F	2.778	36	240	3.081
40-44	F	2.467	30	182	2.801
45-49	F	2.621	29	170	2.411
50-54	F	4.050	19	123	5.440
55-59	F	4.770	22	94	4.710
60-64	F	5.350	17	98	5.720
65-69	F	5.684	19	117	4.164
70-74	F	3.286	14	77	2.920
75+	F	5.130	23	108	3.659

The age-group/sex strata averages, age-group/sex strata sample standard deviation, sample size, and stratum size are provided. The estimates and the 95% C.I. for the true population (S.F.H.C.) means are:

Overall Mean:	3.380 +/- 0.2840
Mean (men):	2.860 +/- 0.3946
Mean (women):	3.879 +/- 0.4058

The average number of visits made by women in the last year **is** significantly higher than the average number made by men. A point estimate for the mean difference is 1.0190, and a 95% C.I. for the true mean difference based on the stratified sample is [0.4530, 1.5850]. Since this C.I. does not contain 0, it can be concluded that the mean number of visits in the last year is significantly higher for women than men. Figure 7 displays the data. If only those who attended at least once are considered, the mean for attenders is 4.83 visits (2126/440). Bass reported a mean of 2.9/year.[23]

Fig. 7.


AVERAGE # VISITS IN 1 YEAR
Average # Visits
4
3.5
3
2.5
2
1.5
1
0.5
0
Total
Men
Women

2.2.2 Average Visits: by sex and age

The data in Table 7 refers to the average number of visits to the clinic in the last year (1994). The data is stratified by *age group* and *sex.*

Table 7. The Average Number of Visits by Age Group & Sex

age group	average age	sex	total (sample)	average # of visits
20-24	22.618	M	34	1.500
25-29	26.935	M	31	2.387
30-34	31.592	M	49	2.020
35-39	36.703	M	37	1.676
40-44	42.361	M	36	1.944
45-49	46.650	M	20	2.800
50-54	51.947	M	19	3.000
55-59	56.682	M	22	3.550
60-64	62.357	M	14	5.930
65-69	66.905	M	21	4.619
70-74	71.687	M	16	5.687
75+	77.330	M	9	7.000
20-24	22.156	F	32	2.812
25-29	27.263	F	38	4.658
30-34	31.952	F	42	4.357
35-39	37.139	F	36	2.778
40-44	41.633	F	30	2.467
45-49	46.862	F	29	2.621
50-54	52.158	F	19	4.050
55-59	57.500	F	22	4.770
60-64	62.235	F	17	5.350
65-69	66.737	F	19	5.684
70-74	71.143	F	14	3.286
75+	80.570	F	23	5.130

For each sex, multiple linear regression is used to analyze the relationship between the average number of visits to the clinic in the last year, and the independent variable of *age*. In addition, a second fitted term will be introduced to see if it is also significant: age^2. When both terms and a constant term are fitted in the model, the parameter estimates for **men** are as follows:

Parameter Estimates

parameter	estimate	s.e.	t-ratio	*p*-value
constant	2.843	1.563	1.819	0.1023
age	-0.08923	0.06799	-1.312	0.2219
sqr(age)	0.001851	0.0006767	2.735	0.0230

The linear term has a t-ratio of -1.312 which is not significant (p-value = 0.2219). Since this parameter is not significant, it can be removed from the model. The parameter estimates for this simpler model are as follows:

Parameter Estimates

parameter	estimate	s.e.	t-ratio	*p*-value
constant	0.8380	0.3425	2.447	0.0345
sqr(age)	0.000973	0.0001055	9.222	<0.0001

As can be seen from the p-values, both estimates are significant at 5%. Thus the fitted number of visits to the clinic in 1994 for **men** is: $y = 0.8380 + 0.000973age^2$, where y denotes the fitted number of visits in 1994.

The same procedure can be followed for **women**. The parameter estimates for the full model are as follows:

Parameter Estimates

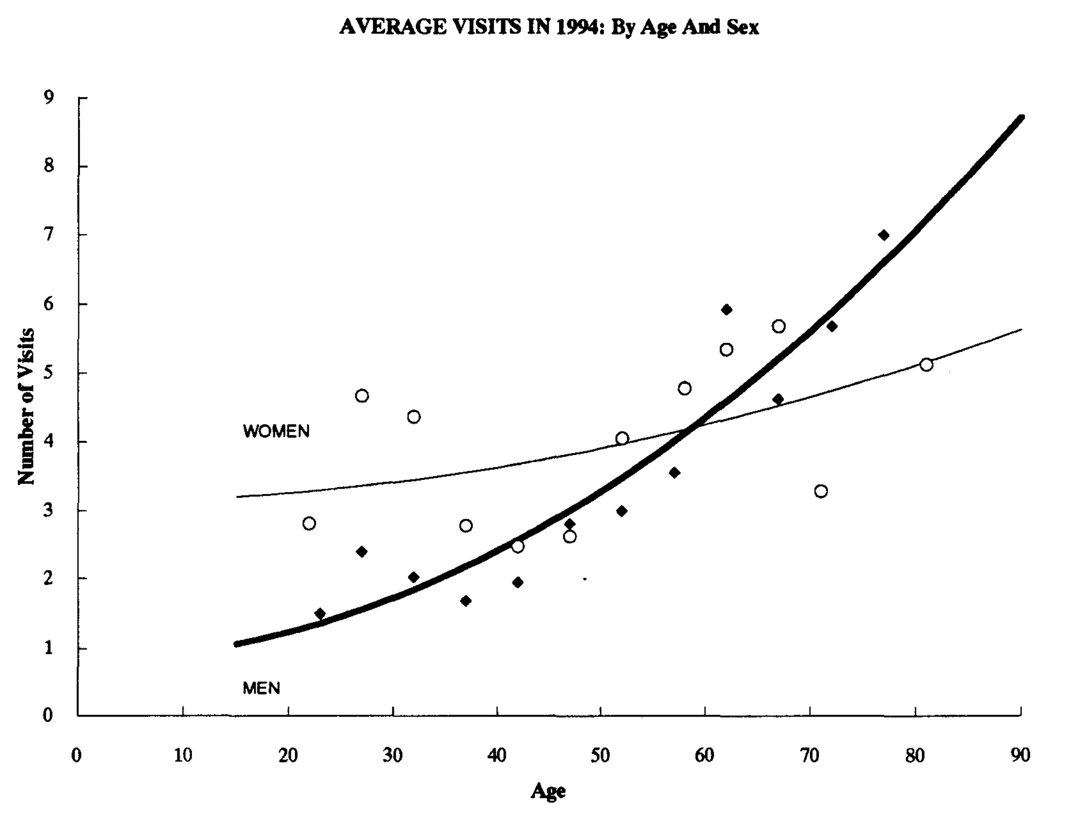
parameter	estimate	s.e.	t-ratio	*p*-value
constant	3.704	2.627	1.410	0.1921
age	-0.02499	0.1119	-0.2234	0.8282
sqr(age)	0.000551	0.001093	0.5042	0.6262

The linear term has a t-ratio of 0.8282 (p-value = 0.8282), which is not significant. As before, this term can be removed from the model. The parameter estimates for the reduced model are as follows:

Parameter Estimates

parameter	estimate	s.e.	t-ratio	*p*-value
constant	3.132	0.5569	5.624	0.0002
sqr(age)	0.0003101	0.0001676	1.850	0.0941

Fig. 8


AVERAGE VISITS IN 1994: By Age And Sex
Number of Visits
WOMEN
MEN
Age
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90

The constant term has a *t*-ratio of 5.624 (*p*-value = 0.0002), which is highly significant. The squared term has a *t*-ratio of 1.850 (*p*-value = 0.0941), which is significant at 10%. Thus the fitted number of visits to the clinic in 1994 for **women** is: $y = 3.132 + 0.0003101age^2$, where y denotes the fitted number of visits in 1994. Figure 8 displays the observed data as well as the fitted curves for both men and women.

As previously noted a greater proportion of women than men visit the clinic (Figure 6). From Figure 8, young men under 30 years of age make an estimate of less than 2 visits/per year, while women of the same age make over 3 visits. For both sexes there was a peak for the age group 25-29 years: women made 4.7 visits and men 2.4 visits. At age 60, both men and women made an estimated 4.2 visits. There was a late peak for men in the age group 60-64 (5.9 visits); and for women in the age group 65-69 (5.7 visits).

2.2.3 Percent Seen at Various Frequency Levels

Table 8 displays the the percentage of patients at various visit frequency levels.

Table 8. The Number of Visits in 1 Year (1994)

# visits	# patients	%
0	189	30%
1-2	147	23%
3-9	240	38%
10+	53	8%
Total	629	100%

In 1991, 84% of Canadian adults (≥ 15 yrs.) made contact with an M.D. during the previous year, while 82% made contact specifically with a G.P. The frequency of contacts during the year with a M.D. (G.P. included) were:[22]

# visits	% patients
0	15%
1-2	42%
3-9	30%
10+	11%

S.F.H.C. spends more time with the moderately heavy users.

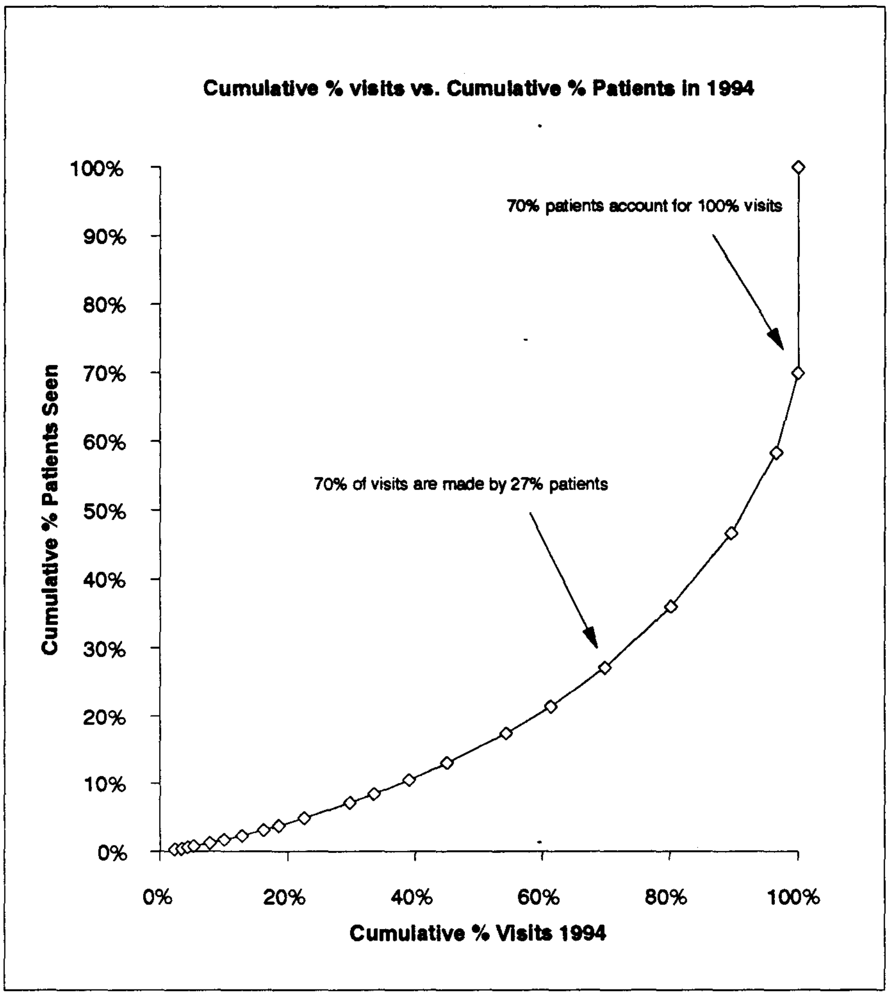
2.2.4 Clinic Utilization: by number of patients and visits

Table 9. Cumulative % of Visits vs. Cumulative % of Patients in 1 Year (1994)

# visits	# patients	total visits	cum.: visits	% total	cum.: pts.	% total
25	2	50	50	2%	2	0%
22	1	22	72	3%	3	0%
20	1	20	92	4%	4	1%
19	1	19	111	5%	5	1%
18	3	54	165	8%	8	1%
16	3	48	213	10%	11	2%
15	4	60	273	13%	15	2%
14	5	70	343	16%	20	3%
13	4	52	395	19%	24	4%
12	7	84	479	23%	31	5%
11	14	154	633	30%	45	7%
10	8	80	713	34%	53	8%
9	13	117	830	39%	66	10%
8	16	128	958	45%	82	13%
7	28	196	1154	54%	110	17%
6	25	150	1304	61%	135	21%
5	36	180	1484	70%	171	27%
4	55	220	1704	80%	226	36%
3	67	201	1905	90%	293	47%
2	74	148	2053	97%	367	58%
1	73	73	2126	100%	440	70%
0	189	0	2126	100%	629	100%
Total	629	2126				

In Table 9 the frequency of visits and the number of patients at each frequency level have been sorted in descending order, from heavy users to infrequent users. The cumulative percentages of *patients seen* are compared to the cumulative percentages of *visits made*. The data is displayed in Figure 9. 30% of the practice did not attend in the year, i.e. 70% of patients accounted for 100% of the work done by the clinic. Figure 9 also indicates that 27% of patients account for 70% of visits, i.e. the clinic spends a disproportionate amount of time with a relatively small group of patients. These may have a heavier burden of illness and are likely to be older. McWhinney noted that, over a period of twenty years, 25% of the population had about 75% of illness.[31] This skewing of activity is reflected in the lower proportion of the practice seen in a year: 70% compared to the approximately 80% reported by others.[22, 29]

Fig. 9.


Cumulative % visits vs. Cumulative % Patients in 1994
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative % Patients Seen
70% patients account for 100% visits
70% of visits are made by 27% patients
0%
20%
40%
60%
80%
100%
Cumulative % Visits 1994

3. Contact With the Same or Different Providers

The data in Table 10 refers to the number of patients in the sample who came to the clinic for a given number of visits in the last year (1994). Also provided is the average number of health care providers for each given number of visits. Thus, for all the patients in the sample who came to the clinic four times in 1994, on average, they were seen by 2.436 different providers.

Table 10. The Average Number of Providers for a Given Number of Visits in 1994

# visits	# patients	ave. # providers
0	189	0
1	73	1.000
2	74	1.676
3	67	2.328
4	55	2.436
5	36	3.333
6	25	3.040
7	28	3.643
8	16	4.187
9	13	4.308
10	8	4.625
11	14	5.286
12	7	4.000
13	4	5.500
14	5	6.000
15	4	6.750
16	3	7.000
18	3	5.333
19	1	5.000
20	1	10.000
22	1	10.000
25	2	10.500

Multiple linear regression is used to analyze the relationship between the average number of providers in 1994 (the dependent variable), and the number of visits in 1994 (the independent variable) which will be denoted as x. In addition, a second fitted term will be introduced: the square-root of the number of visits in 1994. For the purpose of curve fitting, the last 5 entries (i.e. 18, 19, 20, 22, and 25 visits) are combined to yield weighted values of 7.750 providers for 20.625 visits on average. This is done because the counts are so small at each entry. When both terms and a constant term are fitted in the model, the parameter estimates are as follows:

Parameter Estimates

parameter	estimate	s.e.	t-ratio	*p*-value
constant	0.04271	0.37010	0.1154	0.9097
x	0.19110	0.06408	2.9820	0.0093
sqrt(x)	0.86030	0.31460	2.7350	0.0153

The constant term has a t-ratio of 0.1154, which is not significant (p-value = 0.9097). Since this parameter estimate is not significant, it can be removed from the model. The parameter estimates for the model without the constant term are as follows:

Parameter Estimates

parameter	estimate	s.e.	t-ratio	*p*-value
x	0.1858	0.04332	4.288	0.0006
sqrt(x)	0.8918	0.15170	5.877	<0.0001

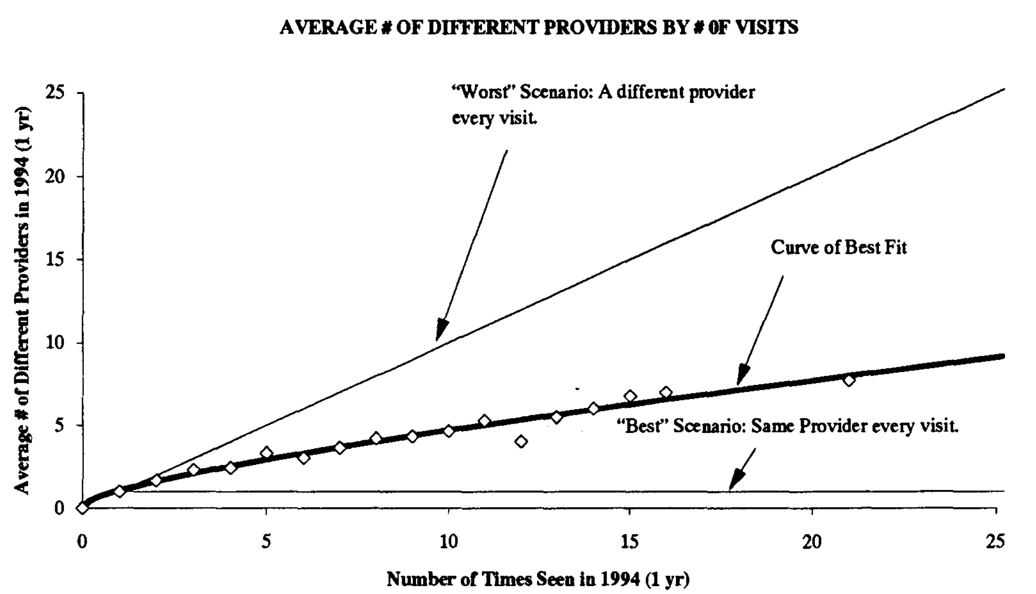
The linear term is significant with a t-ratio of 4.288 (p-value = 0.0006). The square-root term is also significant with a t-ratio of 5.877 (p-value < 0.0001). Thus, the fitted number of providers in 1994 for a given number of visits to the clinic in 1994 is: $y = 0.1858x + 0.8918x^{0.5}$, where y denotes the fitted number of providers in 1994, and x denotes the number of visits in 1994. Fig 10. displays the observed data as well as the fitted values.

In Figure 10, in addition to the line of best fit, two additional lines are drawn: one, the "Worst Scenario" in terms of consistency of provider, is when a different provider is seen by the patient at each visit. The other line, the "Best Scenario" is when the same provider is seen on every visit. The latter could represent a single-handed private practice without the use of a nurse. S.F.H.C. is a teaching practice with five faculty physicians, two nurse practitioners, a social worker, and sixteen family medicine residents, four of whom are full-time at any given period. Furthermore, on July 1 of each year there is a turnover of half the residents (those graduating into private practice and new in-coming trainees). The maximum number of possible providers in any one year is about 32! A line bisecting the angle between the lines of "Best" and "Worst" scenarios would represent a compromise between these extremes. The line of best fit for the clinic fell below that compromise. This model of representation is useful for comparison between clinics, or to monitor continuity of provider at S.F.H.C.

It is not obvious what is the best scenario. What is best for care providers may not be considered best by patients. Some patients like to see "their" physician only, while others especially in an urgent situation don't mind seeing whoever is available. On the other hand, for the most efficient use of resources, interdisciplinary collaboration and teamwork are encouraged by the clinic, which employs nurse practitioners and a social worker. In addition, it is a teaching centre. If the patient's faculty physician only sees the patient, then the residents are deprived of experiential opportunity and faculty do not teach, supervise, or pursue academic endeavours. If only a resident sees the patient then the patient would infrequently see his/her most responsible physician. Furthermore, residents are full-time for four months of the year.

The clinic cannot sustain a one-on-one relationship with patients. It seems that an average of three or four providers is inevitable. Over an episodic condition that requires short term surveillance continuity of provider is possible and desirable. Chronic conditions require monitoring by providers who are permanent members of the clinic, and here the collaboration between faculty and nurse practitioner is essential.

Fig. 10



4. Absence of B.P. Recordings

4.1 No B.P. Record in 5 Years: by sex

The data in Table 11 refer to the number of patients who do not have a B.P. reading in the last five years (1990-1994). The data is stratified by *age group* and *sex.*

Table 11. No B.P. Record in the Last 5 Years

group	sex	no record	sample size	stratum size
20-24	M	13	34	175
25-29	M	17	31	185
30-34	M	19	49	230
35-39	M	11	37	208
40-44	M	12	36	183
45-49	M	6	20	141
50-54	M	5	19	114
55-59	M	2	22	91
60-64	M	0	14	80
65-69	M	1	21	105
70-74	M	1	16	66
75+	M	1	9	68
20-24	F	8	32	207
25-29	F	2	38	202
30-34	F	6	42	238
35-39	F	6	36	240
40-44	F	4	30	182
45-49	F	4	29	170
50-54	F	2	19	123
55-59	F	3	22	94
60-64	F	1	17	98
65-69	F	1	19	117
70-74	F	2	14	77
75+	F	1	23	108

The following estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.2035 +/- 0.0277
proportion (men):	0.2857 +/- 0.0447
proportion (women):	0.1246 +/- 0.0340

The proportion of men without a B.P. reading in the last five years is higher for men than for women. A point estimate for the risk difference is 0.1611, and a 95% C.I. for the true risk difference is [0.1050, 0.2172]. Since the C.I. does not contain 0, it can be concluded that the proportion of men without a B.P. reading taken in the last five years **is significantly higher** than the same proportion for women. Figure 11 displays the data.

4.2 No B.P. Recording AT ALL

The data in Table 11 refer to the number of patients who do not have a B.P. reading in the last five years (1990-1994). The data is stratified by *age group* and *sex.*

Table 12. No B.P. Record AT ALL

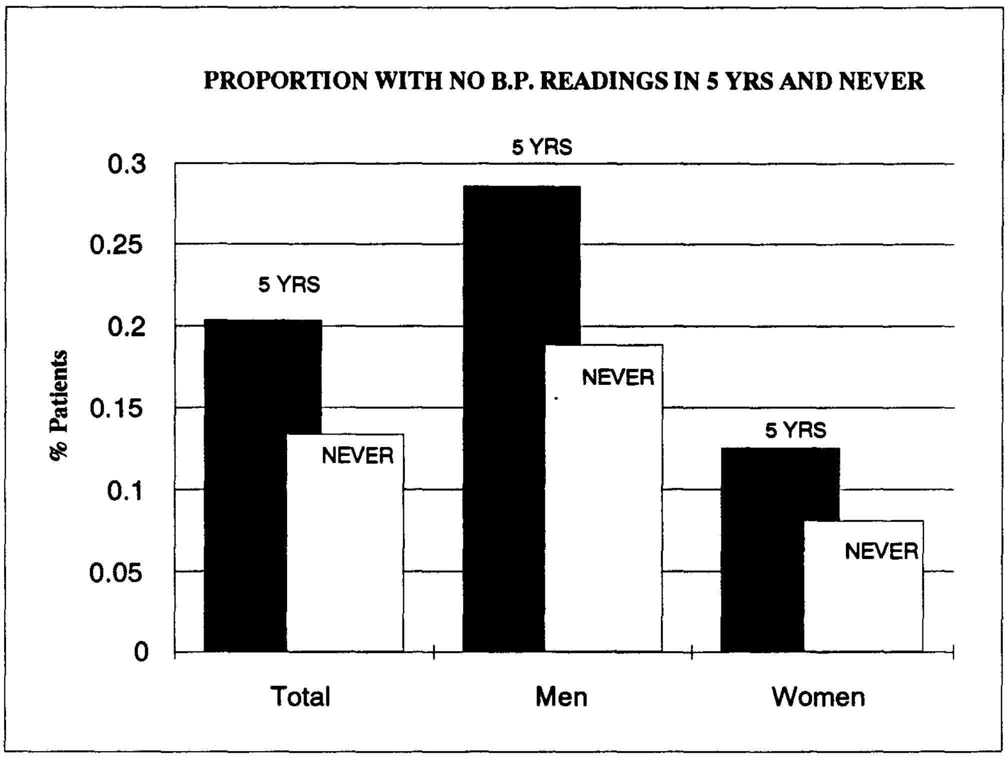
group	sex	no record	sample size	strata size
20-24	M	9	34	175
25-29	M	12	31	185
30-34	M	15	49	230
35-39	M	7	37	208
40-44	M	6	36	183
45-49	M	4	20	141
50-54	M	3	19	114
55-59	M	2	22	91
60-64	M	0	14	80
65-69	M	0	21	105
70-74	M	0	16	66
75+	M	0	9	68
20-24	F	7	32	207
25-29	F	1	38	202
30-34	F	5	42	238
35-39	F	4	36	240
40-44	F	2	30	182
45-49	F	2	29	170
50-54	F	1	19	123
55-59	F	3	22	94
60-64	F	0	17	98
65-69	F	0	19	117
70-74	F	0	14	77
75+	F	1	23	108

The following estimates and the 95% C.I. for the true population proportions (S.F.H.C.) are as follows:

Overall proportion:	0.1335 +/- 0.0234
proportion (men):	0.1883 +/- 0.0388
proportion (women):	0.0810 +/- 0.0276

The proportion of men without a B.P. reading *at all* is higher for men than women. A point estimate for the risk difference is 0.1073, and a 95% C.I. for the true risk difference is [0.0597, 0.1550]. Since the C.I. does not contain 0, it can be concluded that the proportion of men without a B.P. reading at all **is significantly higher** than the same proportion for women. Figure 11 displays the results.

Fig. 11


PROPORTION WITH NO B.P. READINGS IN 5 YRS AND NEVER
% Patients
0.3
0.25
0.2
0.15
0.1
0.05
0
5 YRS
NEVER
5 YRS
NEVER
5 YRS
NEVER
Total
Men
Women

4.3 No B.P. Proportions (Last 5 Years): by sex and age

The data in Table 13 refer to the number of people who do not have a B.P. reading in the last five years (January 1990 to December 1994). The data is stratified by *age group* and *sex*.

Table 13. The Number of Patients With No B.P. Reading in the Last 5 Years

age group	average age	sex	no B.P. (5 yrs.)	total (sample)
20-24	22.618	M	13	34
25-29	26.935	M	17	31
30-34	31.592	M	19	49
35-39	36.703	M	11	37
40-44	42.361	M	12	36
45-49	46.650	M	6	20
50-54	51.947	M	5	19
55-59	56.682	M	2	22
60-64	62.357	M	0	14
65-69	66.905	M	1	21
70-74	71.687	M	1	16
75+	77.330	M	1	9
20-24	22.156	F	8	32
25-29	27.263	F	2	38
30-34	31.952	F	6	42
35-39	37.139	F	6	36
40-44	41.633	F	4	30
45-49	46.862	F	4	29
50-54	52.158	F	2	19
55-59	57.500	F	3	22
60-64	62.235	F	1	17
65-69	66.737	F	1	19
70-74	71.143	F	2	14
75+	80.570	F	1	23

The linear logistic model is again used to analyze the relationship between the absence of a B.P. reading in the last five years, and the independent variables of *age* and *sex*. The deviances (and reduction in deviance) on fitting each of the successive models follow. *Sex* is fitted first.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	78.96	23		
const., sex	53.33	22	25.62	1
const., sex, age	23.39	21	29.94	1
const., sex, age, sex.age	18.19	20	5.205	1

The model with only the constant term has an overall deviance of 78.96 (23 d.f.). There is a significant lack of fit as the *p*-value is < 0.0001. When *sex* is fitted, the reduction in deviance is 25.62 (1 d.f.) which is significant (*p*-value < 0.0001). The reduction in deviance is 29.94 (1 d.f.) when *age* is fitted, which is highly significant (*p*-value $<$ 0.0001). The interaction effect is also significant, as the reduction in deviance is 5.205 (1 d.f.), with a *p*-value = 0.0225. Thus, when *sex* is fitted first, the main effects of *sex* and *age,* and the interaction effect, are all significant. Similar results are obtained when *age* is fitted first.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	78.96	23		
const., sex	47.83	22	31.13	1
const., sex, age	23.39	21	24.44	1
const., sex, age, sex.age	18.19	20	5.205	1

Although both main effects and the interaction are significant at 5%, the overall deviance when only the main effects are fitted is 23.39 (21 d.f.), which indicates a good fit (as the lack of fit is not significant: *p*-value = 0.3235). Thus, the simplest model with a good fit would only include the main effects of *age* and *sex.*

As in the case with the previous data, *sex* is significant. For this reason, separate linear logistic models are constructed for both men and women. The parameter estimates for the linear logistic model where the proportion of ***men*** who do not have a B.P. reading in the last five years are as follows:

Parameter Estimates

parameter	estimate	s.e.	Est./s.e.	p-value
constant	1.185	0.4078	2.905	0.0037
age	-0.05192	0.01019	-5.098	<0.0001

Similarly, the parameter estimates for ***women*** are as follows:

Parameter Estimates

parameter	estimate	s.e.	Est./s.e.	p-value
constant	-1.174	0.4721	-2.488	0.0129
age	-0.01798	0.01068	-1.683	0.0923

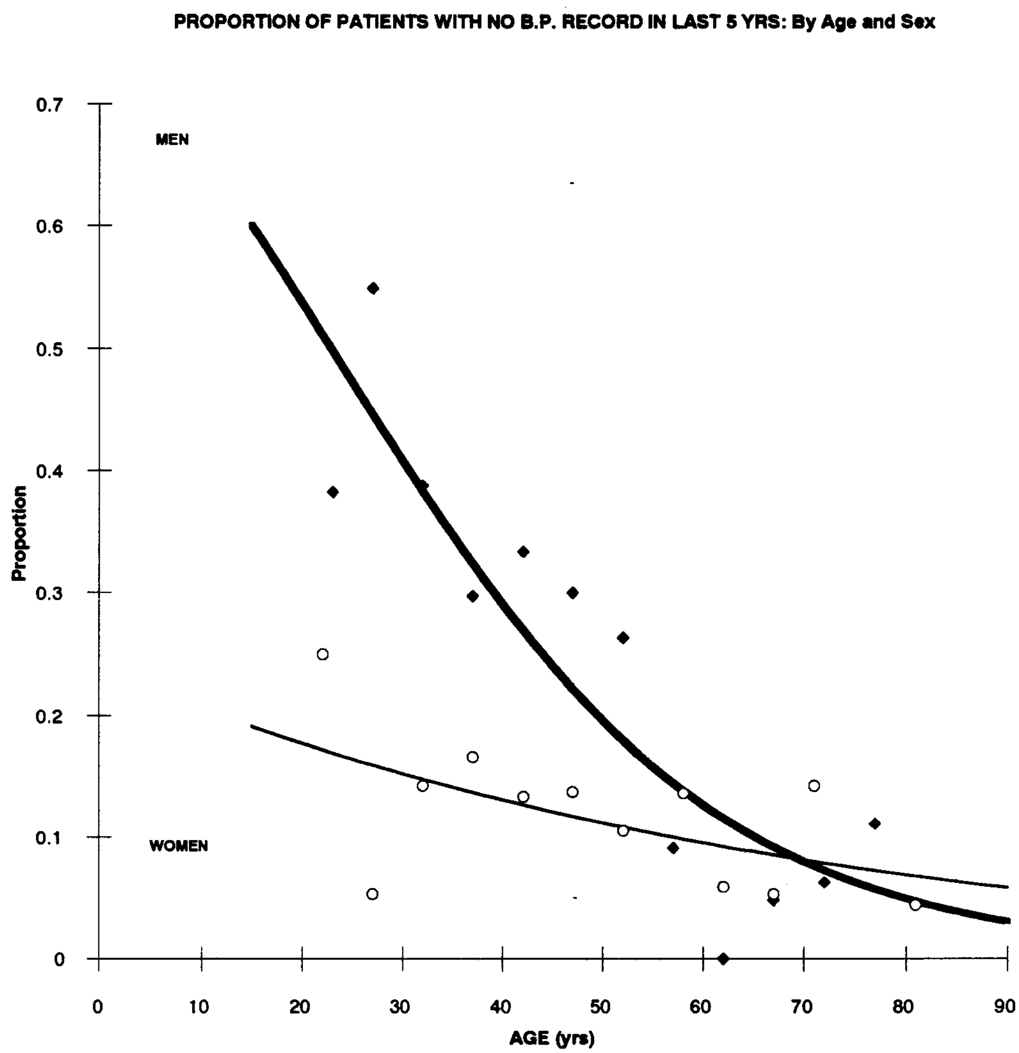
All parameter estimates are significant at 5%, except for the *age* parameter for women. This parameter is significant at 10% (*p*-value = 0.0923). The equations for the fitted probabilities for each sex are:

$$\hat{p}_{No\ B.P.\ Taken\ in\ last\ 5\ years:\ Men} = \frac{\exp(1.185 - 0.05192age)}{1 + \exp(1.185 - 0.05192age)}$$

$$\hat{p}_{No\ B.P.\ Taken\ in\ last\ 5\ years:\ Women} = \frac{\exp(-1.174 - 0.01798age)}{1 + \exp(-1.174 - 0.01798age)}$$

Figure 12 displays the two linear logistic models for men and women, as well as the observed values. From the fitted curve, at age 20-24, an estimated 54% of males and 18% of females did not have their blood pressure recorded within five years. At age 40-44, an estimated 30% of men and 14% of women did not have a B.P. recorded; and at age 65-69, 9% of both men and women had no B.P. recorded. Dramatically, this demonstrates the problem of delivering health promoting interventions to young male adults. As a group they are infrequent visitors to the clinic.

Fig. 12


PROPORTION OF PATIENTS WITH NO B.P. RECORD IN LAST 5 YRS: By Age and Sex
Proportion
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
MEN
WOMEN
0
10
20
30
40
50
60
70
80
90
AGE (yrs)

4.4 Cumulative Practice Proportion With B.P. Readings

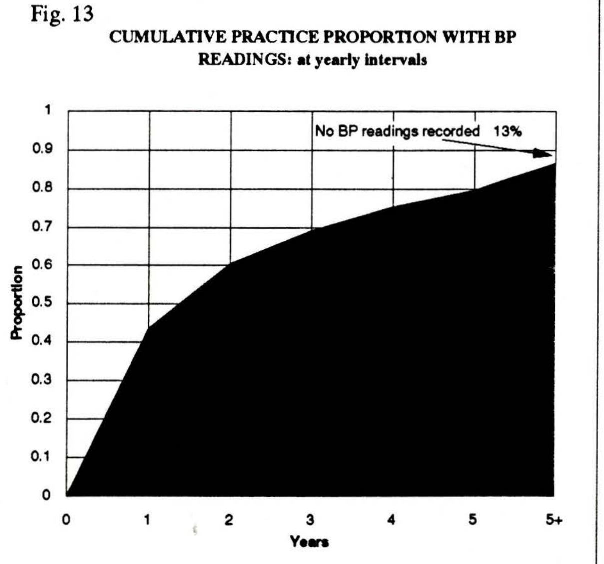
Table 14 displays the cumulative proportions of patients with B.P readings at yearly intervals.

Table 14. Cumulative Percentage With B.P. Readings

year	# patients	cum. total	%
1	274	274	44
2	107	381	61
3	54	435	69
4	39	474	75
5	27	501	80
5+	44	545	87
Never	84	629	100

Figure 13 represents practice coverage of B.P recording, over successive years. In one year only 44% of the practice had their B.P taken; two years - 61%; 3 yrs - 69%; and five years - 80%. 13% never had their B.P recorded. The clinic's coverage in one year is very low The *Ontario Health Survey 1990* reported 73% females and 63% males had their B.P checked in the previous year.[29] The *Canadian Blood Pressure Survey* reported a rate of 75% in the previous year and that 75% of the monitoring was done by doctors and 20% by nurses.[32] A rate of 75% was reported for Hamilton-Wentworth region.[33] Dunn, in Toronto, reported that 83% of adults who visited their doctor in a two year period had their B.P. taken at least once.[34] S.F.H.C. had a coverage of 61% of the practice in two years, and 80% in five years, which indicates that a five-year screening cycle, at current rates, would cover 80% of patients.

Fig. 13



5. Elevated Blood Pressure

5.1 Elevated B.P. Proportions: by sex

The data in Table 15 refer to the number of patients with E.B.P. (including those with diagnosed hypertension) out of the total number of people who have had a blood pressure reading. The data is stratified by *age group* and *sex.*

Table 15. The Number of Patients With Elevated Blood Pressure

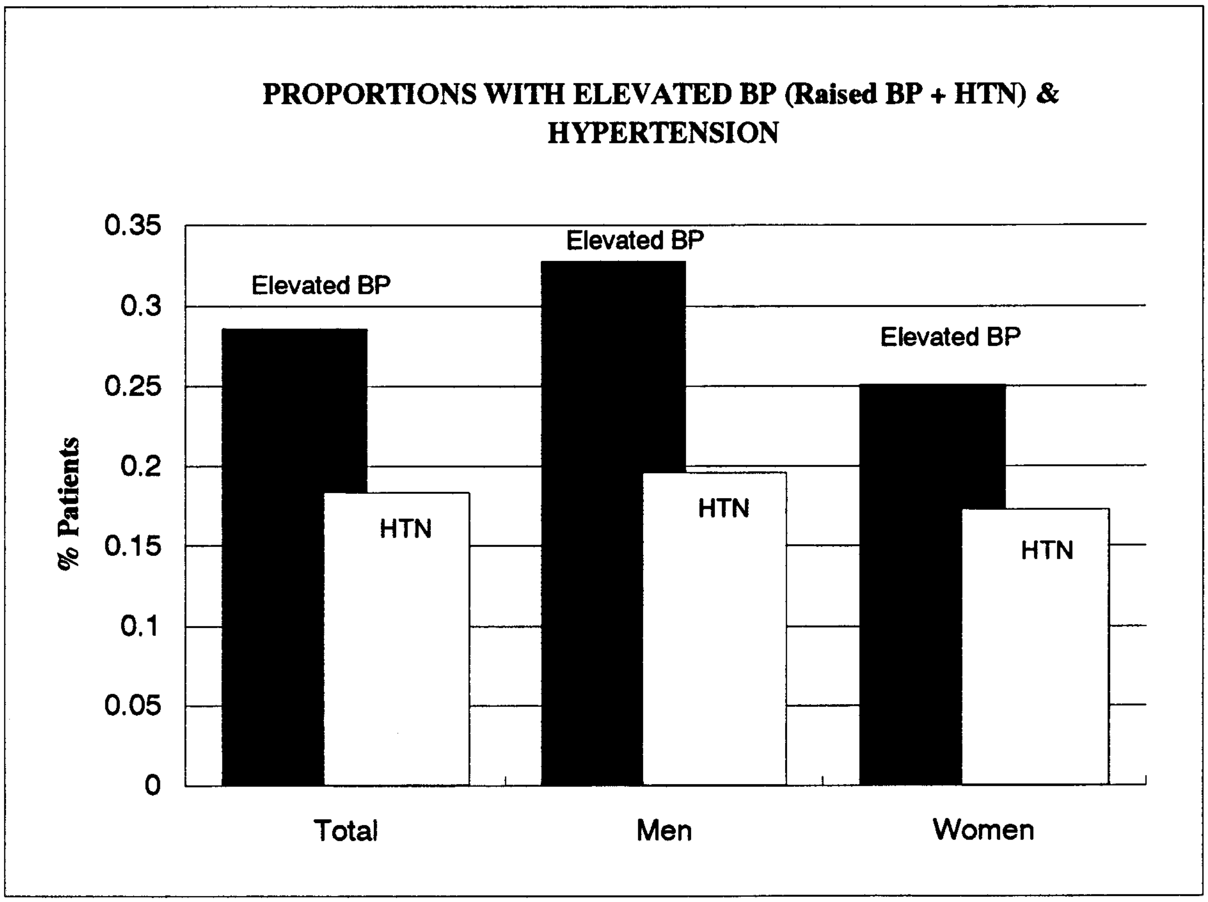
group	sex	E.B.P.	sample size	stratum size
20-24	M	1	25	175
25-29	M	0	19	185
30-34	M	6	34	230
35-39	M	4	30	208
40-44	M	12	30	183
45-49	M	8	16	141
50-54	M	9	16	114
55-59	M	11	20	91
60-64	M	7	14	80
65-69	M	11	21	105
70-74	M	10	16	66
75+	M	3	9	68
20-24	F	2	25	207
25-29	F	2	37	202
30-34	F	1	37	238
35-39	F	2	32	240
40-44	F	7	28	182
45-49	F	5	27	170
50-54	F	7	18	123
55-59	F	9	19	94
60-64	F	6	17	98
65-69	F	10	19	117
70-74	F	7	14	77
75+	F	16	22	108

The following estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.2862 +/- 0.0302
proportion (men):	0.3280 +/- 0.0470
proportion (women):	0.2508 +/- 0.0389

The prevalence of elevated B.P. is higher for men than women. A point estimate for the risk difference is 0.0772, and a 95% C.I. for the true risk difference is [0.0161, 0.1382]. Since the C.I. does not contain 0, it can be concluded that the proportion of men with elevated blood pressure **is significantly higher** than women. Figure 14 displays the data.

Fig. 14


PROPORTIONS WITH ELEVATED BP (Raised BP + HTN) & HYPERTENSION
% Patients
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Elevated BP
HTN
Elevated BP
HTN
Elevated BP
HTN
Total
Men
Women

5.2 Elevated B.P. Proportions: by sex and age

The data in Table 16 refer to the number of patients with elevated blood pressure (including those with diagnosed hypertension) out of the total number of people who have had a blood pressure reading. The data is stratified by *age group* and *sex*.

Table 16. The Number of Patients With Elevated B.P.

age group	average age	sex	elevated B.P.	total (sample)
20-24	22.618	M	1	25
25-29	26.935	M	0	19
30-34	31.592	M	6	34
35-39	36.703	M	4	30
40-44	42.361	M	12	30
45-49	46.650	M	8	16
50-54	51.947	M	9	16
55-59	56.682	M	11	20
60-64	62.357	M	7	14
65-69	66.905	M	11	21
70-74	71.687	M	10	16
75+	77.330	M	3	9
20-24	22.156	F	2	25
25-29	27.263	F	2	37
30-34	31.952	F	1	37
35-39	37.139	F	2	32
40-44	41.633	F	7	28
45-49	46.862	F	5	27
50-54	52.158	F	7	18
55-59	57.500	F	9	19
60-64	62.235	F	6	17
65-69	66.737	F	10	19
70-74	71.143	F	7	14
75+	80.570	F	16	22

The linear logistic model is again used to analyze the relationship between E.B.P. and the independent variables of *age* and *sex*. The deviances (and reduction in deviance) on fitting each of the successive models follow (*sex* is fitted first).

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	141	23		
const., sex	137	22	3.934	1
const., sex, age	32.35	21	104.7	1
const., sex, age, sex.age	30.91	20	1.443	1

The model with only the constant term has an overall deviance of 141.0 (23 d.f.). There is a significant lack of fit as the ***p***-value is < 0.0001. When *sex* is fitted, the reduction in deviance is 3.934 (1 d.f.) which *is* significant (*p*-value = 0.0473). The reduction in deviance is 104.7 (1 d.f.) when *age* is fitted, which is highly significant (*p*-value < 0.0001). The interaction effect is not significant, as the reduction in deviance is only 1.443 at 1 d.f. (*p*-value = 0.2297). Thus, when *sex* is fitted first, only the main effects of *sex* and *age* are significant.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	141.00	23		
const., sex	37.91	22	103.0	1
const., sex, age	32.35	21	5.561	1
const., sex, age, sex.age	30.91	20	1.443	1

When *age* is fitted first, we obtain similar results: *age* (*p*-value < 0.0001) and *sex* (*p*-value = 0.0184) are highly significant, while the interaction effect is not significant. Thus, regardless of the order, similar results are obtained. The final model contains the main effects of *age*, *sex,* and the constant term. The overall deviance is 32.35 (21 d.f.) which indicates a good fit (as the lack of fit test has a *p*-value = 0.0539). Since *sex* is significant, the data can not be combined. The linear logistic model is fitted where the dependent variable is the proportion of ***men*** with elevated B.P. and the explanatory variable is *age*. The parameter estimates are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	-3.269	0.4843	-6.75	<0.0001
age	0.05369	0.009377	5.726	<0.0001

The Wald ratios clearly indicate that the constant term and *age* are highly significant, as the *p*-values are both < 0.0001. The equation for the fitted probability of having elevated B.P. at a given age is:

$$\hat{p}_{E.B.P:Men} = \frac{\exp(-3.269 + 0.05369age)}{1 + \exp(-3.269 + 0.05369age)}$$

The linear logistic model is fitted where the dependent variable is the proportion of ***women*** with elevated B.P., and the explanatory variable is *age*. The parameter estimates are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	-4.594	0.5342	-8.600	<0.0001
age	0.06975	0.009545	7.308	<0.0001

The Wald ratios indicate that the constant term and *age* are highly significant, as both ***p***-value are < 0.0001. The equation for the fitted probability of having elevated B.P. at a given age is:

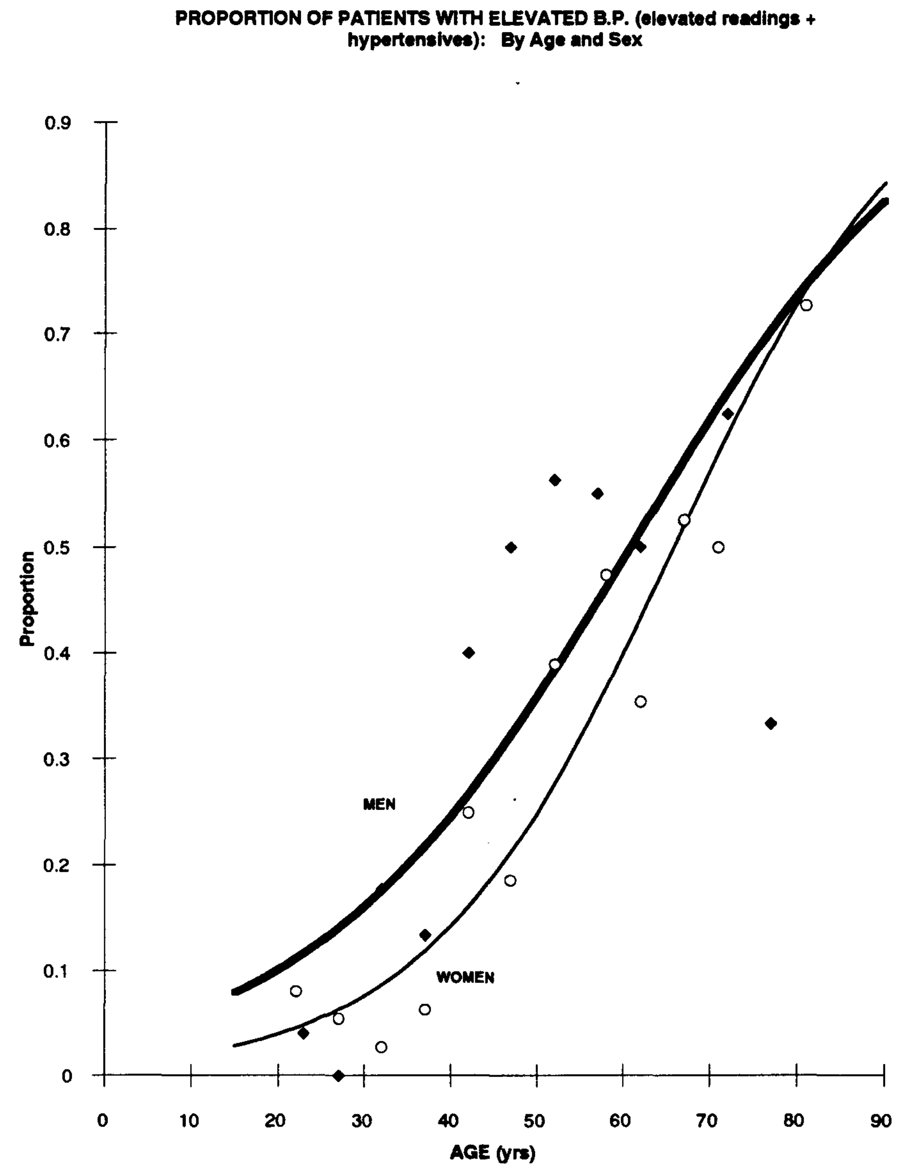
$$\hat{p}_{E.B.P:Women} = \frac{\exp(-4.594 + 0.06975age)}{1 + \exp(-4.594 + 0.06975age)}$$

Figure 15 displays the two linear logistic models for men and women, as well as the observed values.

Overall, there is a significant difference between men and women with respect to elevated B.P. At each age group, the proportion for men is higher than for women. The difference tapers off as age progresses, and women after the menopause begin to have a similar profile (with respect to elevated B.P.) as men. An interesting feature is that only three men out of nine (0.33) in the 75+ age group had elevated B.P. There are two reasons for this apparent outlier the first being that it is just an outlier, since the stratum size of nine is so small. The alternative is that we expected a higher proportion in the 75+ group than the previous age group (0.625). That the observed proportion was only 0.33 might be that a significant number of men in this age group with elevated B.P. did not survive, inflating the proportion of normotensive men. There were only nine men surviving in this cohort, compared to twenty-two women. Relatively, women with elevated BP appeared to have fared better than their male counterparts. When this outlier is removed, a revised model can be constructed for men (< 75). The equation (without the 75+ data point) for the fitted probability of having elevated B.P. at a given age is:

$$\hat{p}_{E.B.P.:Men(<75)} = \frac{\exp(-3.694 + 0.06408age)}{1 + \exp(-3.694 + 0.06408age)}$$

Fig 15


PROPORTION OF PATIENTS WITH ELEVATED B.P. (elevated readings + hypertensives): By Age and Sex
Proportion
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
MEN
WOMEN
0
10
20
30
40
50
60
70
80
90
AGE (yrs)

6. Diagnosed Hypertension

6.1 Hypertension Proportions: by sex

The data in Table 17 refer to the number of cases of diagnosed hypertension (out of the total number of people who have had a blood pressure reading taken at the clinic), in the sample. The data is stratified by *age group* and *sex*.

Table 17. The Number of Patients With Diagnosed Hypertension

group	sex	diagnosed HTN	sample size	stratum size
20-24	M	0	25	175
25-29	M	0	19	185
30-34	M	4	34	230
35-39	M	0	30	208
40-44	M	4	30	183
45-49	M	3	16	141
50-54	M	5	16	114
55-59	M	5	20	91
60-64	M	6	14	80
65-69	M	10	21	105
70-74	M	10	16	66
75+	M	2	9	68
20-24	F	0	25	207
25-29	F	0	37	202
30-34	F	0	37	238
35-39	F	1	32	240
40-44	F	3	28	182
45-49	F	4	27	170
50-54	F	5	18	123
55-59	F	6	19	94
60-64	F	6	17	98
65-69	F	10	19	117
70-74	F	4	14	77
75+	F	12	22	108

The diagnosed hypertension counts, sample size, and stratum size are provided. The following estimates and the 95% C.I. for the true population (S.F.H.C.) proportions are as follows:

Overall proportion:	0.1834 +/- 0.0248
proportion (men):	0.1960 +/- 0.0377
proportion (women):	0.1729 +/- 0.0327

Since the 95% C.I. for the overall population prevalence does not contain the 0.15 value, it can be concluded that the prevalence of hypertension for the S.F.H.C.. **is higher** than the national prevalence.

Although the prevalence of hypertension is higher for men than women, it **is not** statistically significantly higher. A point estimate for the risk difference is 0.0231, and a 95% C.I. for the true risk difference is [-0.0268, 0.0731]. Since this C.I. contains 0, it can be concluded that the proportion for men is **not** significantly higher than for women. Similarly, Ontario's prevalence is 16% for men and 14% for women, a 2% difference.[22] Figure 14 displays the data.

6.2 Hypertension Proportions: by sex and age

The data in Table 18 refer to the number of cases of diagnosed hypertension out of the total number of people who have had a blood pressure reading taken at the clinic, in the sample. The data is stratified by *age group* and *sex*.

Table 18. The Number of Patients With Diagnosed Hypertension

age group	average age	sex	diagnosed HTN	total (sample)
20-24	22.618	M	0	25
25-29	26.935	M	0	19
30-34	31.592	M	4	34
35-39	36.703	M	0	30
40-44	42.361	M	4	30
45-49	46.650	M	3	16
50-54	51.947	M	5	16
55-59	56.682	M	5	20
60-64	62.357	M	6	14
65-69	66.905	M	10	21
70-74	71.687	M	10	16
75+	77.330	M	2	9
20-24	22.156	F	0	25
25-29	27.263	F	0	37
30-34	31.952	F	0	37
35-39	37.139	F	1	32
40-44	41.633	F	3	28
45-49	46.862	F	4	27
50-54	52.158	F	5	18
55-59	57.500	F	6	19
60-64	62.235	F	6	17
65-69	66.737	F	10	19
70-74	71.143	F	4	14
75+	80.570	F	12	22

The linear logistic model is used to analyze the data where the response variable is the proportion of patients with diagnosed hypertension, and the independent variables are *sex* and *age*. The deviances (and reduction in deviance) on fitting each of the successive models follow, where *sex* is fitted first.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	143.6	23		
const., sex	143.1	22	0.4817	1
const., sex, age	32.34	21	110.8	1
const., sex, age, sex.age	32.04	20	0.2991	1

The model with only the constant term has an overall deviance of 143.6 (23 d.f.). There is a significant lack of fit as the *p*-value is < 0.0001. When *sex* is fitted, the reduction in deviance is only 0.4817 (1 d.f.), which is not significant (*p*-value = 0.4877). The reduction in deviance is 110.8 (1 d.f.) when *age* is fitted, which is highly significant (*p*-value < 0.0001). The interaction effect is not significant as the reduction in deviance is only 0.2991 at 1 d.f. (*p*-value = 0.5844). Thus, when *sex* is fitted first, only the main effect of *age* is significant.

Values of Deviance & Reduction in Deviance

fitted terms	deviance	d.f.	reduction in deviance	d.f. (r. in d.)
const.	143.6	23		
const., age	33.51	22	110.1	1
const., age, sex	32.34	21	1.169	1
const., age, sex, sex.age	32.04	20	0.2991	1

When age is fitted first, we obtain similar results: *age* is highly significant, while *sex* and the interaction term are not significant. Thus, regardless of the order, *sex* and the interaction effect are found to be insignificant in explaining the response probabilities. The final model with a good fit contains the main effect of *age* and the constant term. The overall deviance is 33.51 (22 d.f.), which indicates a good fit (as the lack of fit test has a *p*-value = 0.0551). The parameter estimates are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	-5.381	0.4843	-11.13	<0.0001
age	0.07515	0.008215	9.147	<0.0001

The fitted probability of diagnosed hypertension at a given age is:

$$\hat{p}_{Hypertension} = \frac{\exp(-5.381 + 0.07515age)}{1 + \exp(-5.381 + 0.07515age)}$$

The Wald ratios have been calculated, and from the *p*-values (both < 0.0001), it is evident that both parameter estimates are significant. The observed probabilities of diagnosed hypertension, as well as those predicted by the model are calculated.

Although *sex* is **not** significant, separate linear logistic models are constructed for both men and women. The parameter estimates for ***men*** are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	-4.998	0.6824	-7.324	<0.0001
age	0.07078	0.01194	5.927	<0.0001

Similarly, the parameter estimates for ***women*** are as follows:

Parameter Estimates

parameter	estimate	s.e.	est./s.e.	p-value
constant	-5.783	0.6923	-8.354	<0.0001
age	0.07983	0.01144	6.979	<0.0001

All parameter estimates are highly significant (all *p*-values < 0.0001). The equations for the fitted probabilities for each sex are:

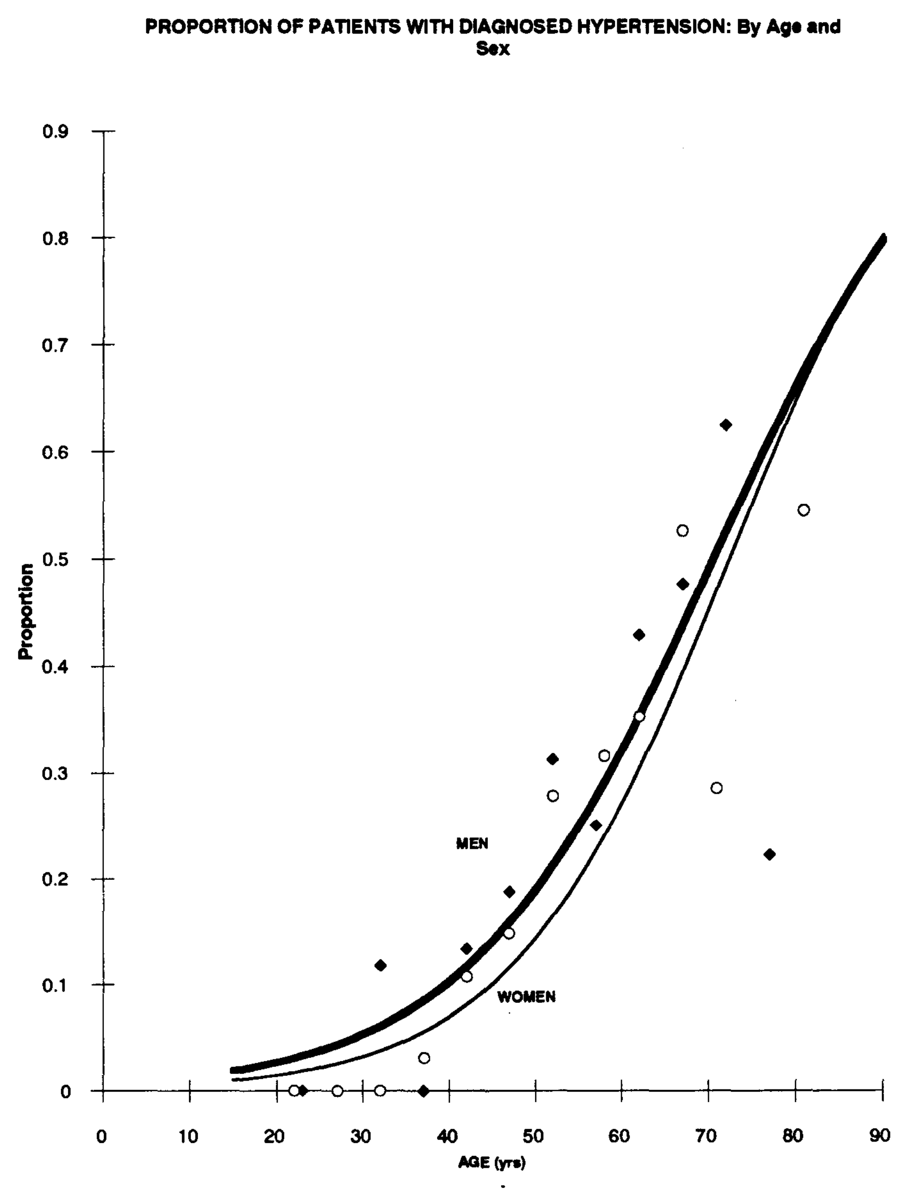
$$\hat{p}_{Hypertension:\,Men} = \frac{\exp(-4.998 + 0.07078 age)}{1 + \exp(-4.998 + 0.07078 age)}$$

$$\hat{p}_{Hypertension:\,Women} = \frac{\exp(-5.783 + 0.07983 age)}{1 + \exp(-5.783 + 0.07983 age)}$$

Figure 16 displays the two linear logistic models for men and women, as well as the observed values. It is quite evident that the prevalence of hypertension increases dramatically with age. From the curve of best fit, at age group 35-39, the prevalence for men is 5% and women 3%; at 60-64, 32% for men and 28% for women; and at 70-74, 50% for men and 46% for women. The rate for women approaches that of men in old age.

An interesting feature in the results is the observation that only two men out of nine (0.22) in the 75+ age group had hypertension. As with the similar outlier for elevated B.P., there are two reasons for this apparent outlier, the first being that it is just an outlier, since the stratum size of nine is so small. The alternative is that we expected a higher proportion in the 75+ group than in the previous age group (0.625 with hypertension). That the observed proportion was only 0.22 might be that a significant number of men in this age group with hypertension did not survive, inflating the proportion of normotensive men.

Fig. 16


PROPORTION OF PATIENTS WITH DIAGNOSED HYPERTENSION: By Age and Sex
Proportion
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
MEN
WOMEN
0
10
20
30
40
50
60
70
80
90
AGE (yrs)

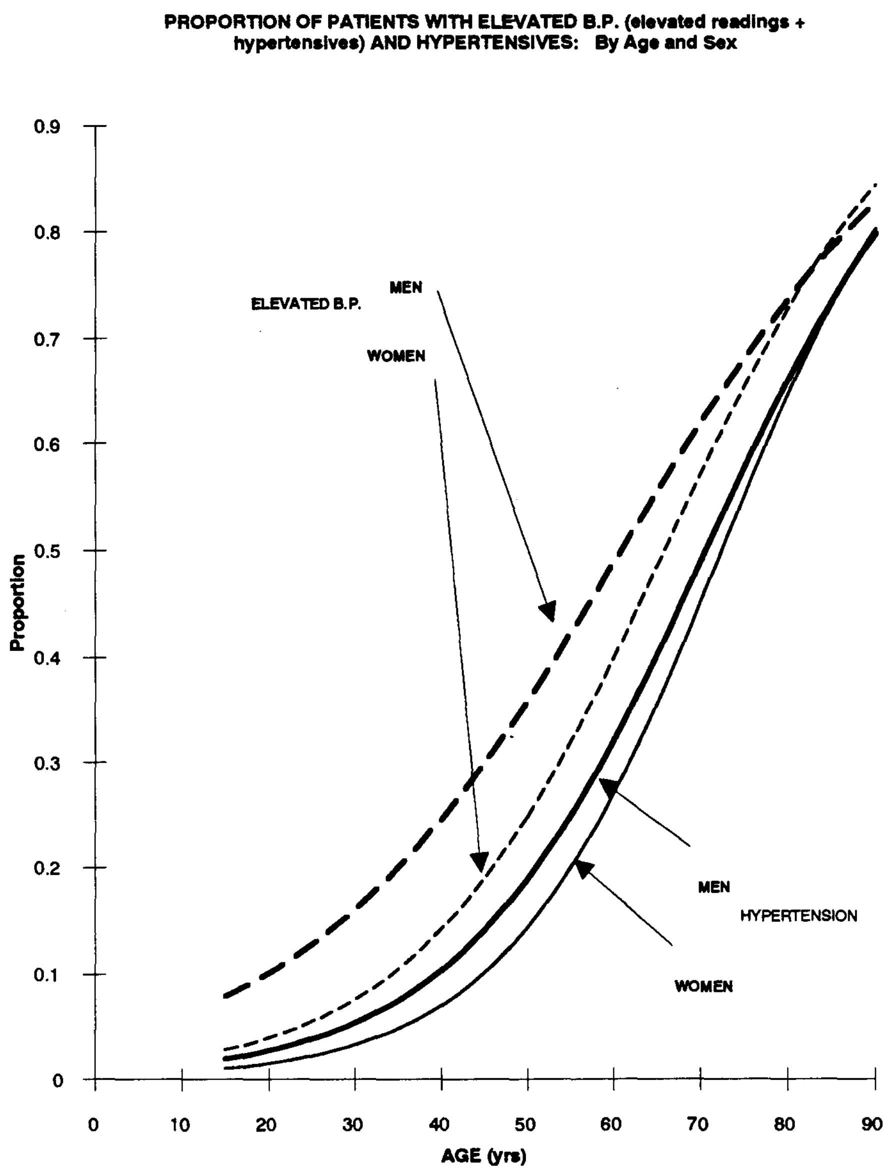
There were only nine men surviving in this cohort, compared to twenty-two women. Relatively, women with hypertension appeared to have fared better than their male counterparts. When this outlier is removed, a revised model can be constructed for men (under the age of 75). The equation (without the 75+ data point) for the fitted probability of diagnosed hypertension at a given age is:

$$\hat{p}_{Hypertension:\, Men\,(<75)} = \frac{\exp(-5.678 + 0.08555age)}{1 + \exp(-5.678 + 0.08555age)}$$

Joffres reports that hypertension defined as a D.B.P. ≥ 90 mmHg had a prevalence at age 25-34 of 9% for men and 3% for women; at 55-64, the prevalence for men was 33% and 32% for women. At age 65-74, (with either the S.B.P. ≥ 140; the D.B.P. ≥ 90; or normal B.P., but on treatment for hypertension) the rates were 52% for men and 58% for women.[16]

Figure 17. combines Figures 15 and 16. From Figure 17, at age 45 the prevalence of hypertension was 15% for men and 10% for women. The prevalence of raised B.P. recordings was the same. However, the differences between the proportions with hypertension and elevated B.P. narrows with advancing age. At age 70, 50% men and 46% women were hypertensive, but only 14% had raised B.P. readings. A hypothesis that could account for the *relative* reduction in raised B.P., is that members of this group became hypertensive. Joffres has noted that for Canada, while 15% had hypertension, an equal proportion had elevated B.P. on some (if not all) occasions.[16] Also, mild hypertension progresses to more serious elevations.[17]

Fig. 17


PROPORTION OF PATIENTS WITH ELEVATED B.P. (elevated readings + hypertensives) AND HYPERTENSIVES: By Age and Sex
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Proportion
ELEVATED B.P.
MEN
WOMEN
MEN
HYPERTENSION
WOMEN
0
10
20
30
40
50
60
70
80
90
AGE (yrs)

7. Management of Hypertension

From the sample, 100 patients had a diagnosis of hypertension. These charts were reviewed in more detail to assess the effectiveness of care. The results are analyzed using 2x2 contingency table analysis (*Appendix E*).

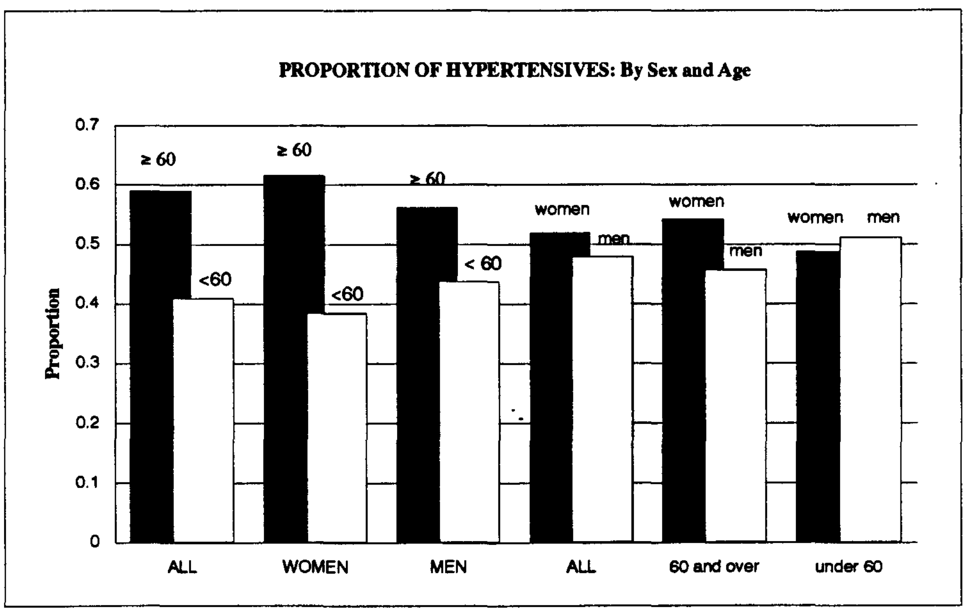
7.1 Diagnosis of Hypertension: by sex and age

	≥60	<60			odds ratio	90% Confidence Interval	*p-value* 1- sided
females	32	20	52	61.54%			
males	27	21	48	56.25%			
	59	41			1.24	0.6368 - 2.4320	0.3692
	54.24%	48.78%					

The proportion of hypertensive men who are *60 and older* is 0.5625. The same proportion for women is 0.6154. This **is not** significantly higher (1-sided p-value = 0.3692) using Fisher's Exact Test. The point estimate for the odds ratio is 1.2444 and the 90% C.I. for the true odds ratio is [0.6368, 2.4320]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

The proportions of hypertensive by sex and age are displayed in Figure 18.

Fig. 18



7.2 Proportions of Treated Hypertension

7.2.1 Proportions Treated: by sex

		Treated	Not-Treated					
females	all	42	10	52	80.77%	odds	90% Confidence	*p-value*
males	all	37	11	48	77.08%	ratio	Interval	1- sided
		79	21			1.25	0.5561 - 2.8035	0.4177
		53.16%	47.62%					

The proportion of hypertensive men who were treated is 0.7708. The proportion of hypertensive women who were treated is 0.8077. This **is not** significantly higher (1-sided p-value = 0.4177) using Fisher's Exact Test. The point estimate for the odds ratio is 1.2486 and the 90% C.I. for the true odds ratio is [0.5561, 2.8035]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.2.2 Proportions Treated: males by age

		Treated	Not-Treated					
males	≥60	22	5	27	81.48%	odds	90% Confidence	*p-value*
	<60	15	6	21	71.43%	ratio	Interval	1- sided
		37	11			1.76	0.5639 - 5.4935	0.3155
		59.46%	45.45%					

The proportion of hypertensive men *under the age of 60* who were treated is 0.7143. The proportion of hypertensive men *60 and older* who were treated is 0.8148. This **is not** significantly higher (1-sided p-value = 0.3155) using Fisher's Exact Test. The pointestimate for the odds ratio is 1.7600 and the 90% C.I. for the true odds ratio is [0.5639, 5.4935]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.2.3 Proportions Treated: females by age

		Treated	Not-Treated					
females	≥60	28	4	32	87.50%	odds	90% Confidence	*p-value*
	<60	14	6	20	70.00%	ratio	Interval	1- sided
		42	10			3.00	0.9121 - 9.8668	0.1167
		66.67%	40.00%					

The proportion of hypertensive women *under the age of 60* who were treated is 0.7000. The proportion of hypertensive women *60 and older* who were treated is 0.8750. This **is not** significantly higher (1-sided p-value = 0.1167) using Fisher's Exact Test. The point estimate for the odds ratio is 3.000 and the 90% C.I. for the true odds ratio is [0.9121, 9.8668]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.2.4 *Proportions Treated: by age*

		Treated	Not-Treated					
all	≥60	50	9	59	84.75%	odds	90% Confidence	*p-value*
	<60	29	12	41	70.73%	ratio	Interval	1- sided
		79	21			2.30	1.0117 - 5.2234	0.0753
		63.29%	42.86%					

The proportion of hypertensives *under the age of 60* who were treated is 0.7073. The proportion of hypertensives *60 and older* who were treated is 0.8475. This **is** significantly higher (1-sided *p*-value = 0.0753) using Fisher's Exact Test, at 10% significance. The point estimate for the odds ratio is 2.2989 and the 90% C.I. for the true odds ratio is [1.0117, 5.2234]. Since the C.I. does not contain 1, we can conclude that at a significance of 10%, the proportions **are** significantly different.

7.2.5 *Proportions Treated: under 60 years by sex*

		Treated	Not-Treated					
<60	males	15	6	21	71.43%	odds	90% Confidence	*p-value*
	females	14	6	20	70.00%	ratio	Interval	1- sided
		29	12			1.07	0.3463 - 3.3150	0.5951
		51.72%	50.00%					

The proportion of hypertensive women *under the age of 60* who were treated is 0.7000. The proportion of hypertensive men *under the age of 60* who were treated is 0.7143. This **is not** significantly higher (1-sided *p*-value = 0.5951) using Fisher's Exact Test. The point estimate for the odds ratio is 1.0714 and the 90% C.I. for the true odds ratio is [0.3463, 3.3150]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

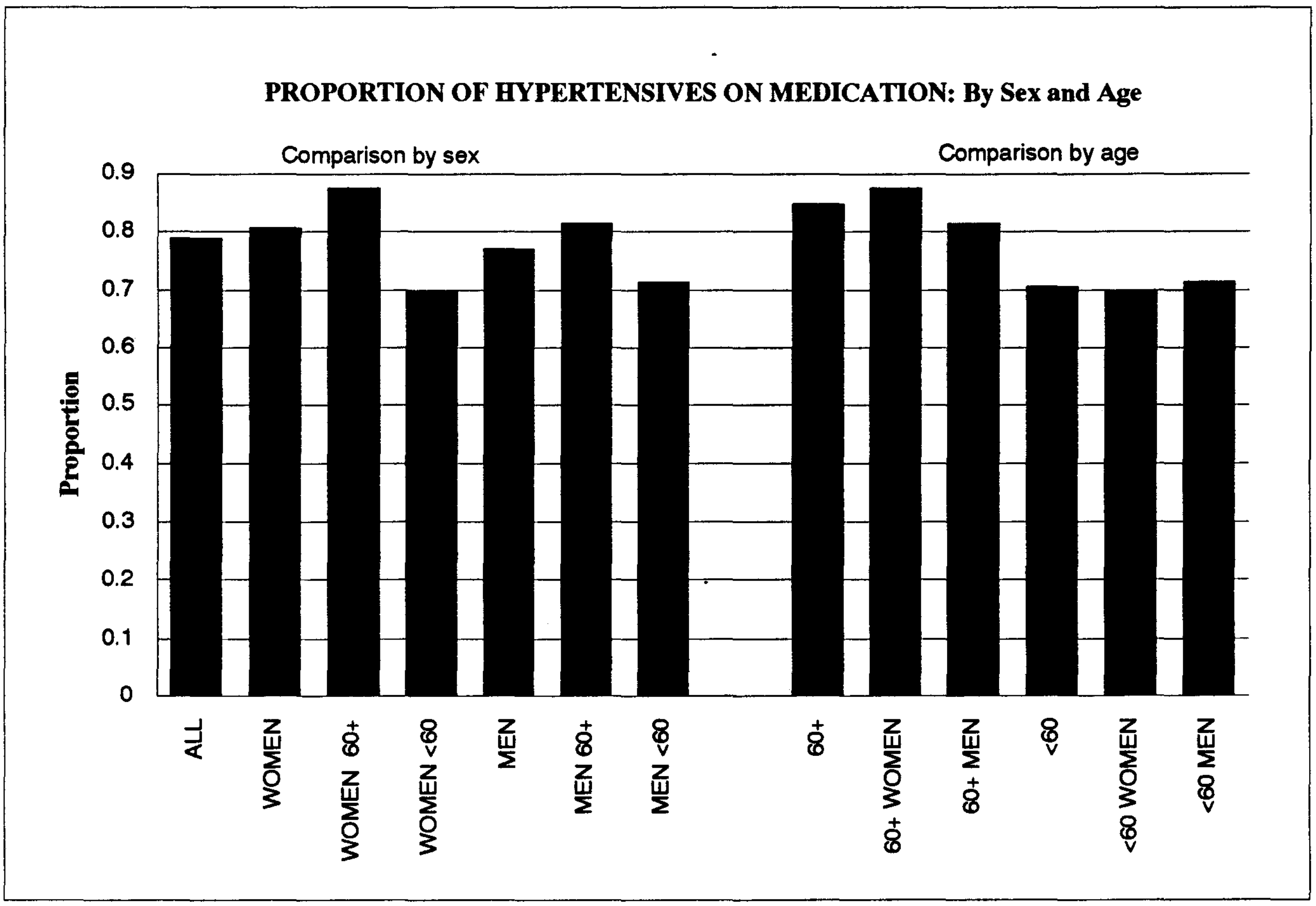
7.2.6 *Proportions Treated: over 60 years by sex*

		Treated	Not-Treated					
≥60	females	28	4	32	87.50%	odds	90% Confidence	*p-value*
	males	22	5	27	81.48%	ratio	Interval	1- sided
		50	9			1.59	0.4797 - 5.2762	0.389
		56.00%	44.44%					

The proportion of hypertensive men *60 and older* who were treated is 0.8148. The proportion of hypertensive women *60 and older* who were treated is 0.8750. This **is not** significantly higher (1-sided *p*-value = 0.3890) using Fisher's Exact Test. The point estimate for the odds ratio is 1.5909 and the 90% C.I. for the true odds ratio is [0.4797, 5.2762]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

Figure 19 displays the treated proportions of hypertensives, by sex and age.

Fig. 19


PROPORTION OF HYPERTENSIVES ON MEDICATION: By Sex and Age
Comparison by sex
Comparison by age
Proportion
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ALL
WOMEN
WOMEN 60+
WOMEN <60
MEN
MEN 60+
MEN <60
60+
60+ WOMEN
60+ MEN
<60
<60 WOMEN
<60 MEN

7.3 Hypertension Control

7.3.1 Proportions Controlled: by sex

		Control	No-Control			odds ratio	90% Confidence Interval	*p-value* 1- sided
females	all	33	19	52	63.46%			
males	all	29	19	48	60.42%			
		62	38			1.14	0.5774 - 2.2424	0.4571
		53.23%	50.00%					

The proportion of hypertensive men who were controlled is 0.6042. The proportion of hypertensive women who were controlled is 0.6346. This is **not** significantly higher (1-sided *p*-value = 0.4571) using Fisher's Exact Test. The point estimate for the odds ratio is 1.1379 and the 90% C.I. for the true odds ratio is [0.5774, 2.2424]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.3.2 Proportions Controlled: males by age

		Control	No-Control			odds ratio	90% Confidence Interval	*p-value* 1- sided
males	≥60	17	10	27	62.96%			
	<60	12	9	21	57.14%			
		29	19			1.28	0.4796 - 3.3895	0.4547
		58.62%	52.63%					

The proportion of hypertensive men *under the age of 60* who were controlled is 0.5714. The proportion of hypertensive men *60 and older* who were controlled is 0.6296. This **is not** significantly higher (1-sided *p*-value = 0.4547) using Fisher's Exact Test. The point estimate for the odds ratio is 1.2750 and the 90% C.I. for the true odds ratio is [0.4796, 3.3895]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.3.3 Proportions Controlled: females by age

		Control	No-Control			odds ratio	90% Confidence Interval	*p-value* 1- sided
females	<60	16	4	20	80.00%			
	60	17	15	32	53.13%			
		33	19			3.53	1.1882 - 10.4835	0.0464
		48.48%	21.05%					

The proportion of hypertensive women *60 and older* who were controlled is 0.5313. The proportion of hypertensive women *under the age of 60* who were controlled is 0.8000. This **is** significantly higher (1-sided *p*-value = 0.0464) using Fisher's Exact Test. The point estimate for the odds ratio is 3.5294 and the 90% C.I. for the true odds ratio is [1.1882, 10.4835]. Since the C.I. does not contain 1, we can conclude that at a significance of 10%, the proportions **are** significantly different.

7.3.4 Proportions Controlled: by age

		Control	No-Control					
all	<60	28	13	41	68.29%	odds	90% Confidence	*p-value*
	≥60	34	25	59	57.63%	ratio	Interval	1- sided
		62	38			1.58	0.7850 - 3.1952	0.1921
		45.16%	34.21%					

The proportion of hypertensive patients *60 and older* who were controlled is 0.5763. The proportion of hypertensive patients *under the age of 60* is 0.6829. This **is not** significantly higher (1-sided *p*-value = 0.1921) using Fisher's Exact Test. The point estimate for the odds ratio is 1.5837 and the 90% C.I. for the true odds ratio is [0.7850, 3.1952]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.3.5 Proportions Controlled: under 60 years and by sex

		Control	No-Control					
<60	females	16	4	20	80.00%	odds	90% Confidence	*p-value*
	males	12	9	21	57.14%	ratio	Interval	1- sided
		28	13			3.00	0.9299 - 9.6780	0.1078
		57.14%	30.77%					

The proportion of hypertensive men *under the age of 60* who were controlled is 0.5714. The proportion of hypertensive women *under the age of 60* who were controlled is 0.8000. This **is not** significantly higher (1-sided *p*-value = 0.1078) using Fisher's Exact Test. The point estimate for the odds ratio is 3.000 and the 90% C.I. for the true odds ratio is [0.9299, 9.6780]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

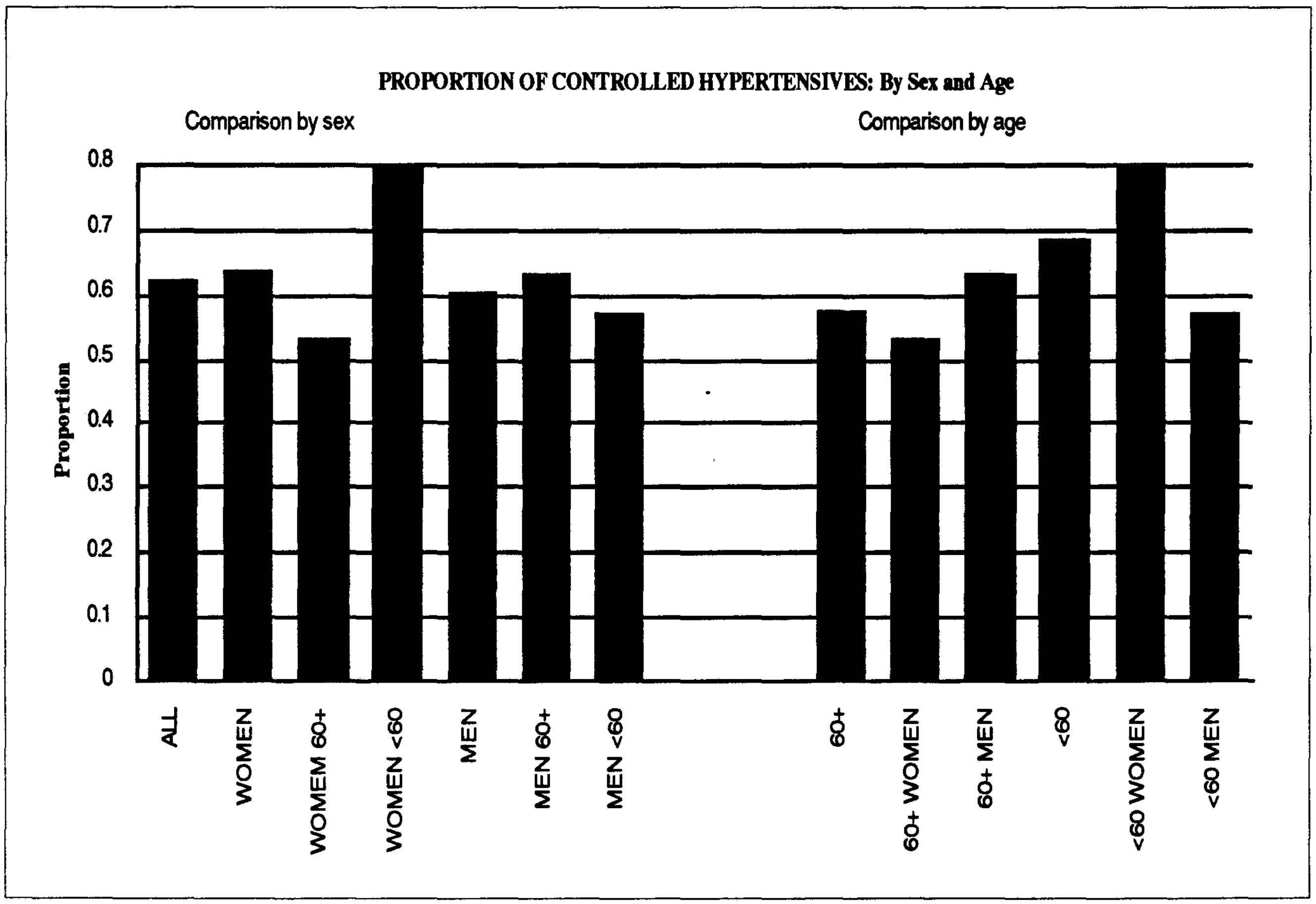
7.3.6 Proportions Controlled: over 60 years and by sex

		Control	No-Control					
≥60	males	17	10	27	62.96%	odds	90% Confidence	*p-value*
	females	17	15	32	53.13%	ratio	Interval	1- sided
		34	25			1.50	0.6240 - 3.6060	0.31
		50.00%	40.00%					

The proportion of hypertensive women *60 and older* who were controlled is 0.5313. The proportion of hypertensive men *60 and older* who were controlled is 0.6296. This **is not** significantly higher (1-sided *p*-value = 0.3100) using Fisher's Exact Test. The point estimate for the odds ratio is 1.5000 and the 90% C.I. for the true odds ratio is [0.6240, 3.6060]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

Figure 20 displays the proportions of treatment control, by sex and age.

Fig. 20


PROPORTION OF CONTROLLED HYPERTENSIVES: By Sex and Age
Comparison by sex
Comparison by age
Proportion
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ALL
WOMEN
WOMEM 60+
WOMEN <60
MEN
MEN 60+
MEN <60
60+
60+ WOMEN
60+ MEN
<60
<60 WOMEN
<60 MEN

7.4 Hypertension Control in Treated and Untreated Groups

7.4.1 Proportions Controlled: treated and untreated

		Control	No-Control					
all	+	52	27	79	65.82%	odds	90% Confidence	*p-value*
	-	10	11	21	47.62%	ratio	Interval	1- sided
		62	38	100		2.12	0.9351 - 4.7997	0.1021
		83.87%	71.05%					

The proportion of *un-treated* hypertensive patients who were controlled is 0.4762. The proportion of *treated* hypertensive patients who were controlled is 0.6582. This **is not** significantly higher (1-sided *p*-value = 0.1021) using Fisher's Exact Test. The point estimate for the odds ratio is 2.1185 and the 90% C.I. for the true odds ratio is [0.9351, 4.7997]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.4.2 Proportions Controlled: males

		Control	No-Control					
males	+	24	13	37	64.86%	odds	90% Confidence	*p-value*
	-	5	6	11	45.45%	ratio	Interval	1- sided
		29	19			2.22	0.7043 - 6.9681	0.2096
		82.76%	68.42%					

The proportion of **u**n-treated hypertensive men who were controlled is 0.4545. The proportion of treated hypertensive men who were controlled is 0.6487. This **is not** significantly higher (1-sided *p*-value = 0.2096) using Fisher's Exact Test. The point estimate for the odds ratio is 2.2154 and the 90% C.I. for the true odds ratio is [0.7043, 6.9681]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.4.3 Proportions Controlled: females

		Control	No-Control					
females	+	28	14	42	66.67%	odds	90% Confidence	*p-value*
	-	5	5	10	50.00%	ratio	Interval	1- sided
		33	19			2.00	0.6198 - 6.4535	0.2647
		84.85%	73.68%					

The proportion of **u**n-treated hypertensive women who were controlled is 0.5000. The proportion of treated hypertensive women who were controlled is 0.6667. This **is not** significantly higher (1-sided *p*-value = 0.2647) using Fisher's Exact Test. The point estimate for the odds ratio is 2.000 and the 90% C.I. for the true odds ratio is [0.6198, 6.4535]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.4.4 Proportions Controlled: under 60 years

		Control	No-Control					
<60	+	20	9	29	68.97%	odds	90% Confidence	*p-value*
		8	4	12	66.67%	ratio	Interval	1- sided
		28	13			1.11	0.3332 3.7055	0.5811
		71.43%	69.23%					

The proportion of **u**n-treated hypertensives *under the age of 60* who were controlled is 0.6667 The proportion of treated hypertensives *under the age of 60* who were controlled is 0.6897 This **is not** significantly higher (1-sided *p*-value = 0.5811) using Fisher's Exact Test. The point estimate for the odds ratio is 1.1111 and the 90% C.I. for the true odds ratio is [0.3332, 3.7055]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

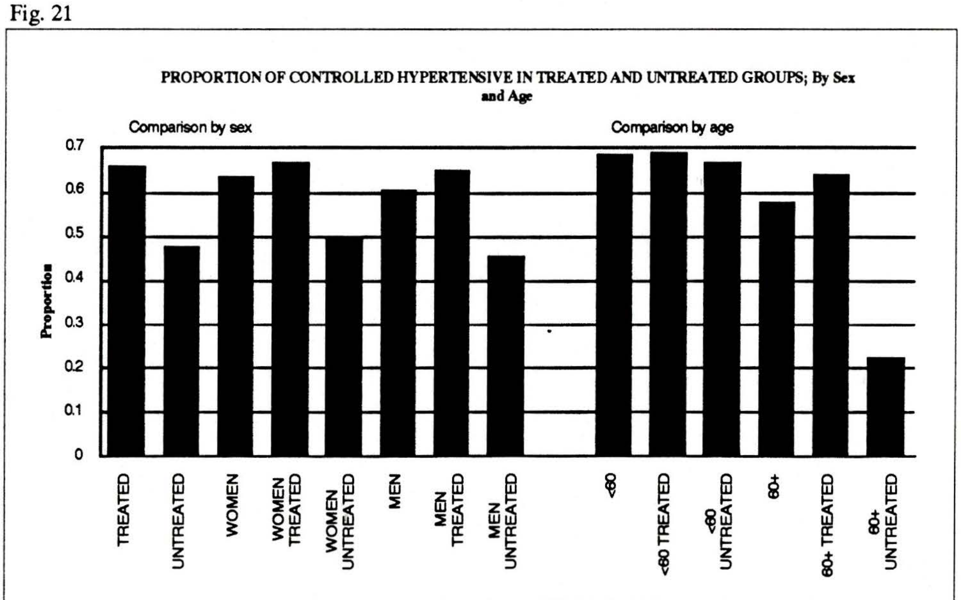
7.4.5 Proportions Controlled. over 60 years

		Control	No-Control					
≥60	+	32	18	50	64.00%	odds	90% Confidence	*p-value*
		2	7	9	22.22%	ratio	Interval	1- sided
		34	25			6.22	1.5265 25.3630	0.0246
		94.12%	72.00%					

The proportion of **u**n-treated hypertensives *60 and older* who were controlled is 0.2222. The proportion of treated hypertensives *60 and older* who were controlled is 0.6400. This **is** significantly higher (1-sided *p*-value = 0.0246) using Fisher's Exact Test. The point estimate for the odds ratio is 6.2222 and the **95**% C.I. for the true odds ratio is [1.1664, 33.1939]. Since the C.I. does not contain 1, we can conclude that at a significance of 10%, the proportions **are** significantly different.

Figure 21 displays the proportions of treated and untreated groups, by sex and age.

Fig. 21



7.5 Patient Compliance

7.5.1 Compliance: by sex

		Compliance	No-Compliance					
males	all	38	10	48	79.17%	odds	90% Confidence	*p-value*
females	all	40	12	52	76.92%	ratio	Interval	1- sided
		78	22			1.14	0.5139 - 2.5291	0.4892
		48.72%	45.45%					

The proportion of hypertensive women who were compliant is 0.7692. The proportion of hypertensive men who were compliant is 0.7917. This is **not** significantly higher (1-sided *p*-value = 0.4892) using Fisher's Exact Test. The point estimate for the odds ratio is 1.1400 and the 90% C.I. for the true odds ratio is [0.5139, 2.5291]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.5.2 Compliance of Males: by age

		Compliance	No-Compliance					
males	≥60	22	5	27	81.48%	odds	90% Confidence	*p-value*
	<60	16	5	21	76.19%	ratio	Interval	1- sided
		38	10			1.38	0.4257 - 4.4409	0.4609
		57.89%	50.00%					

The proportion of hypertensive men *under the age of 60* who were compliant is 0.7619. The proportion of hypertensive men *60 and older* who were compliant is 0.8148. This **is not** significantly higher (1-sided *p*-value = 0.4609) using Fisher's Exact Test. The point estimate for the odds ratio is 1.3750 and the 90% C.I. for the true odds ratio is [0.4257, 4.4409]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.5.3 Compliance of Females: by age

		Compliance	No-Compliance					
females	≥60	26	6	32	81.25%	odds	90% Confidence	*p-value*
	<60	14	6	20	70.00%	ratio	Interval	1- sided
		40	12			1.86	0.6212 - 5.5522	0.2723
		65.00%	50.00%					

The proportion of hypertensive women *under the age of 60* who were compliant is 0.7000. The proportion of hypertensive women *60 and older* who were compliant is 0.8125. This **is not** significantly higher (1-sided *p*-value = 0.2723) using Fisher's Exact Test. The point estimate for the odds ratio is 1.8571 and the 90% C.I. for the true odds ratio is [0.6212, 5.5522]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.5.4 Compliance: by age

		Compliance	No-Compliance					
all	≥60	48	11	59	81.36%	odds	90% Confidence	*p-value*
	<60	30	11	41	73.17%	ratio	Interval	1- sided
		78	22			1.60	0.7196 - 3.5578	0.2328
		61.54%	50.00%					

The proportion of hypertensives *under the age of 60* who were compliant is 0.7317. The proportion of hypertensives *60 and older* who were compliant is 0.8136. This **is not** significantly higher (1-sided p-value = 0.2328) using Fisher's Exact Test. The point estimate for the odds ratio is 1.6000 and the 90% C.I. for the true odds ratio is [0.7196, 3.5577]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.5.5 Compliance: under 60 years and by sex

		Compliance	No-Compliance					
<60	males	16	5	21	76.19%	odds	90% Confidence	*p-value*
	females	14	6	20	70.00%	ratio	Interval	1- sided
		30	11			1.37	0.4283 - 4.3918	0.462
		53.33%	45.45%					

The proportion of hypertensive women *under the age of 60* who were compliant is 0.7000. The proportion of hypertensive men *under the age of 60* who were compliant is 0.7619. This **is not** significantly higher (1-sided p-value = 0.4620) using Fisher's Exact Test. The point estimate for the odds ratio is 1.3714 and the 90% C.I. for the true odds ratio is [0.4283, 4.3918]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

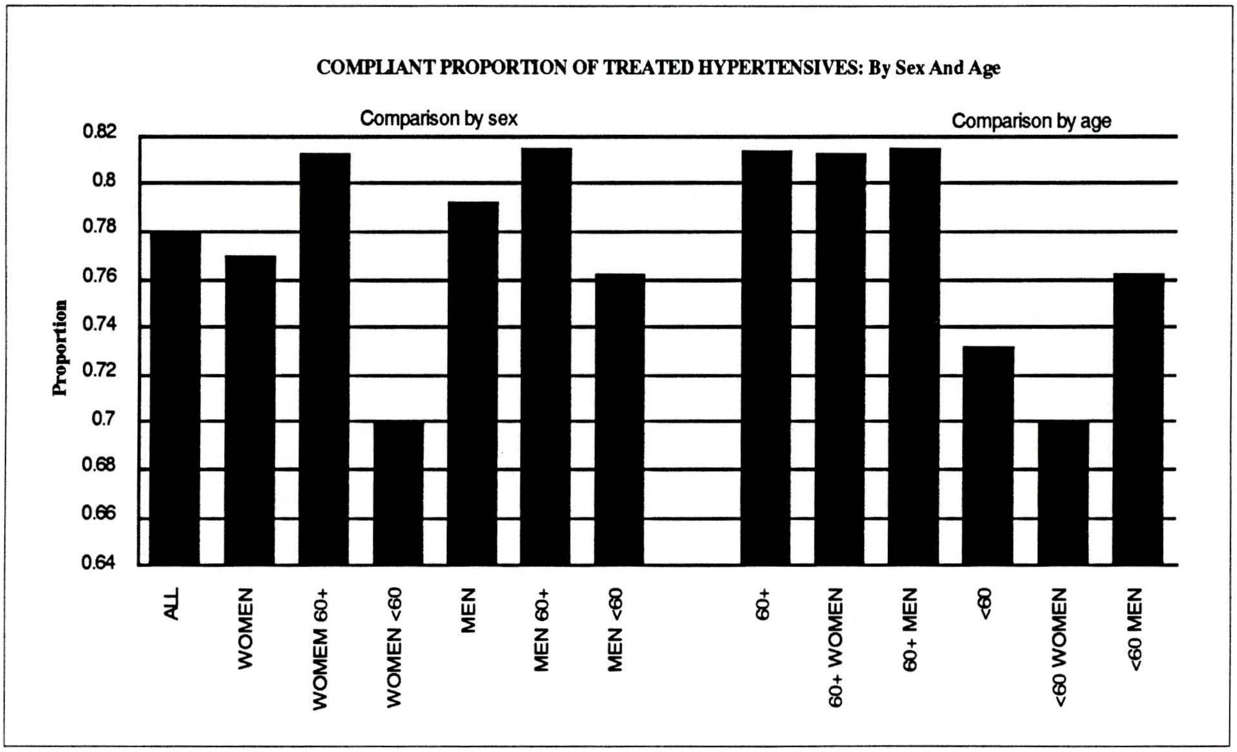
7.5.6 Compliance: over 60 years and by sex

		Compliance	No-Compliance					
≥60	males	22	5	27	81.48%	odds	90% Confidence	*p-value*
	females	26	6	32	81.25%	ratio	Interval	1- sided
		48	11			1.02	0.3366 - 3.0633	0.6242
		45.83%	45.45%					

The proportion of hypertensive women *60 and older* who were compliant is 0.8125. The proportion of hypertensive men *60 and older* who were compliant is 0.8148. This **is not** significantly higher (1-sided p-value = 0.6242) using Fisher's Exact Test. The point estimate for the odds ratio is 1.0154 and the 90% C.I. for the true odds ratio is [0.3366, 3.0633]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

Figure 22 displays the compliance proportions, by sex and age.

Fig. 22


COMPLIANT PROPORTION OF TREATED HYPERTENSIVES: By Sex And Age
Comparison by sex
Comparison by age
Proportion
0.82
0.8
0.78
0.76
0.74
0.72
0.7
0.68
0.66
0.64
ALL
WOMEN
WOMEM 60+
WOMEN <60
MEN
MEN 60+
MEN <60
60+
60+ WOMEN
60+ MEN
<60
<60 WOMEN
<60 MEN

7.6 Target Organ Damage (T.O.D.)

7.6.1 T.O.D.: by sex

		TOD	NO TOD		
males	all	19	22	41	46.34%
females	all	12	26	38	31.58%
		31	48		
		61.29%	45.83%		

odds ratio	90% Confidence Interval	*p-value* 1- sided
1.87	0.8652 - 4.04690	0.133

The proportion of hypertensive women with *known** T.O.D. is 0.3158. The proportion of hypertensive men with *known* T.O.D. is 0.4634. This **is not** significantly higher (1-sided *p*-value = 0.1330) using Fisher's Exact Test. The point estimate for the odds ratio is 1.8712 and the 90% C.I. for the true odds ratio is [0.8652, 4.0469]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.6.2 T.O.D. in Males: by age

		TOD	NO TOD		
males	≥60	13	12	25	52.00%
	<60	6	10	16	37.50%
		19	22		
		68.42%	54.55%		

odds ratio	90% Confidence Interval	*p-value* 1- sided
1.81	0.6163 - 5.2894	0.2793

The proportion of hypertensive men *under the age of 60* with *known** T.O.D. is 0.3750. The proportion of hypertensive men *60 and older* with *known* T.O.D. is 0.5200. This **is not** significantly higher (1-sided *p*-value = 0.2793) using Fisher's Exact Test. The point estimate for the odds ratio is 1.8056 and the 90% C.I. for the true odds ratio is [0.6163, 5.2894]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

7.6.3 T.O.D. in Females: by age

		TOD	NO TOD		
females	≥60	12	17	29	41.38%
	<60	0	9	9	0.00%
		12	26		
		100.00%	65.38%		

odds ratio	90% Confidence Interval	*p-value* 1- sided
-	-	0.0192

The proportion of hypertensive women *under the age of 60* with *known** T.O.D. is 0.0. The proportion of hypertensive women *60 and older* who were treated is 0.3750. This is significantly higher (1-sided *p*-value = 0.0192) using Fisher's Exact Test. Note: The point estimate for the odds ratio and the 90% C.I. for the true odds ratio cannot be calculated due to the 0 entry.

7.6.4 T.O.D.: by age

		TOD	NO TOD					
all	≥60	25	29	54	46.30%	odds	90% Confidence	*p-value*
	<60	6	19	25	24.00%	ratio	Interval	1- sided
		31	48			2.73	1.1192 - 6.6584	0.0489
		80.65%	60.42%					

The proportion of hypertensives *under the age of 60* with *known** T.O.D. is 0.2400. The proportion of hypertensives *60 and older* with *known* T.O.D. is 0.4630. This is significantly higher (1-sided p-value = 0.0488) using Fisher's Exact Test. The point estimate for the odds ratio is 2.7299 and the 90% C.I. for the true odds ratio is [1.1192, 6.6584]. Since the C.I. does not contain 1, we can conclude that at a significance of 10%, the proportions **are** significantly different.

7.6.5 T.O.D.: under 60 years and by sex

		TOD	NO TOD					
<60	males	6	10	16	37.50%	odds	90% Confidence	*p-value*
	females	0	9	9	0.00%	ratio	Interval	1- sided
		6	19			-	-	0.0452
		100.00%	52.63%					

The proportion of hypertensive women *under the age of 60* with *known** T.O.D. is 0.0. The proportion of hypertensive men *under the age of 60* with *known* T.O.D. is 0.3750. This is significantly higher (1-sided p-value = 0.0452) using Fisher's Exact Test.

7.6.6 T.O.D.: over 60 years and by sex

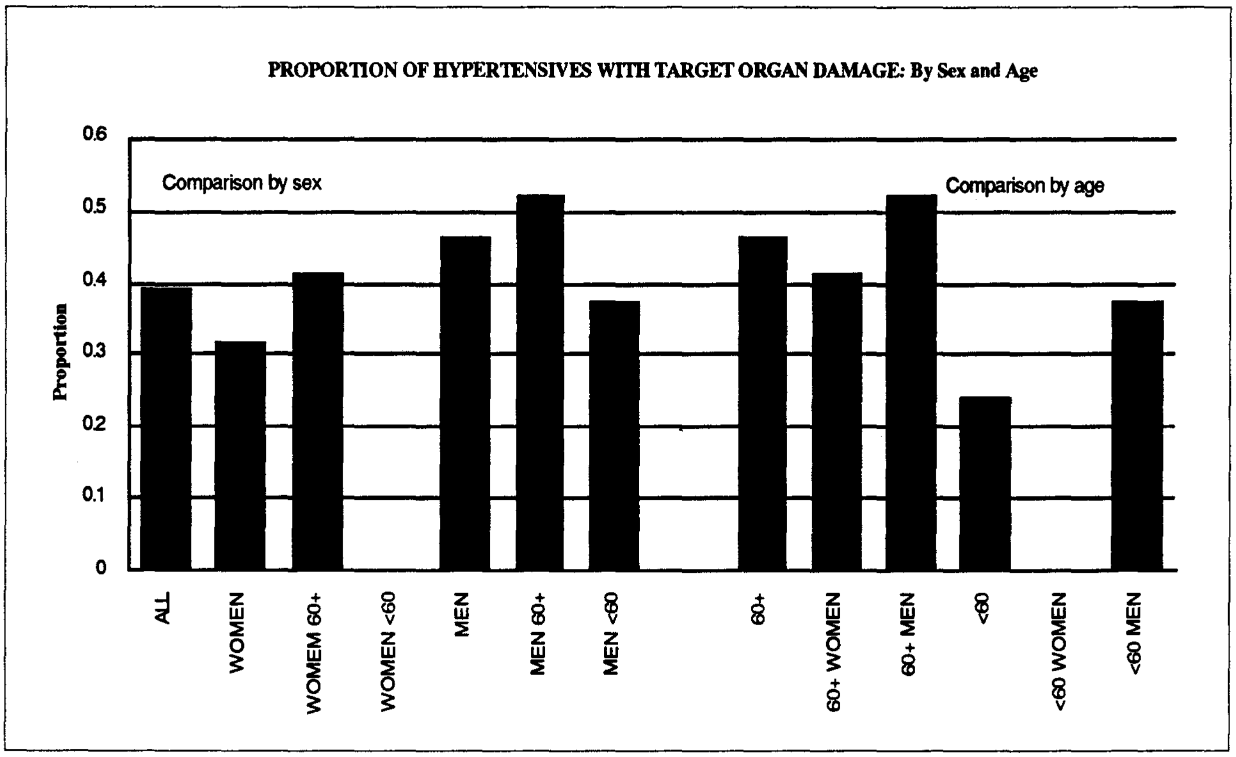
		TOD	NO TOD					
≥60	males	13	12	25	52.00%	odds	90% Confidence	*p-value*
	females	12	17	29	41.38%	ratio	Interval	1- sided
		25	29			1.53	0.6211 - 3.7923	0.3063
		52.00%	41.38%					

The proportion of hypertensive women *60 and older* with *known** T.O.D. is 0.4138. The proportion of hypertensive men *60 and older* with *known* T.O.D. is 0.5200. This is **not** significantly higher (1-sided p-value = 0.3063) using Fisher's Exact Test. The point estimate for the odds ratio is 1.5347 and the 90% C.I. for the true odds ratio is [0.6368, 2.4320]. Since the C.I. contains 1, we can conclude that at a significance of 10%, the proportions **are not** significantly different.

Note: * The counts that had no information concerning T.O.D. were excluded.

Figure 23 displays the proportions with target organ damage, by sex and age.

Fig. 23


PROPORTION OF HYPERTENSIVES WITH TARGET ORGAN DAMAGE: By Sex and Age
Proportion
0.6
0.5
0.4
0.3
0.2
0.1
0
Comparison by sex
Comparison by age
ALL
WOMEN
WOMEM 60+
WOMEN <60
MEN
MEN 60+
MEN <60
60+
60+ WOMEN
60+ MEN
<60
<60 WOMEN
<60 MEN

7.7 Summary of Key Results on Hypertension Management

7.7.1 Hypertension

Hypertensives:	59% were ≥ 60 years old
	52% were women
	74% were on medication
≥ 60 Hypertensives:	54% were women
< 60 Hypertensives:	51% were men

7.7.2 Treatment

Women:	≥ 60	87% were treated
	< 60	70% were treated

~ higher, with a one-sided *p*-value = 0.1167 (close to 10% sig.)

Hypertensives:	≥ 60	85% were treated
	< 60	71% were treated

~ significantly higher, with a one-sided *p*-value = 0.0753 (sig. at 10%)

`There were no significant differences in treatment proportions for those ≥ 60 compared to those < 60 when gender was added. Thus, a greater proportion of older patients were on medication than younger patients, and this was mainly due to the greater proportion of women who were ≥ 60.

7.7.3 Control

Hypertensives:		62% were controlled
Women:	< 60	80% were controlled
	≥ 60	53% were controlled

~ significantly higher, with a one-sided *p*-value = 0.0464 (sig. at 5%)

This proportion for females ≥ 60 years of age was less than for males (63%) of the same age group, though the difference between males and females was not statistically significant. For men, there were no significant differences between those < 60 and those ≥ 60. The findings suggest the need for better management of women ≥ 60.

< 60 Years Old: women 80% were controlled
men 57% were controlled
~ higher, with a one-sided *p*-value = 0.1078 (close to 10% sig.)

This suggests a need for better management of males < 60.

7.7.4 Control With or Without Treatment

Hypertensives: treated 66% were controlled
untreated 48% were controlled
~ higher, with a one-sided *p*-value = 0.1021 (close to 10% sig.)

One expects a difference between treated and untreated groups. However, this is not a controlled experiment, but an audit of treatment practices. The term "treated" actually refers to being treated with medication. Untreated cases are monitored and should the B.P. become elevated, such cases are removed from the untreated group and given medication to bring the B.P. under control. Control would therefore favour both groups. Furthermore, a greater proportion of cases would be assigned to the treated group, leaving a small proportion in the untreated group. Indeed, 79% of all hypertensives were on medication. Despite the above, the results suggest that better surveillance and management is required for the untreated group since the objective is to have ALL hypertensives under adequate control, medicated or not.

≥ 60 Years Old treated 64% were controlled
untreated 22% were controlled
~ significantly higher, with a one-sided *p*-value = 0.0246 (sig. at 5%)

This indicates that better management is required for those 60 years and over. Close scrutiny of the B.P. readings for uncontrolled B.P. in this age group reveals that 42% (25/59) had a S.B.P. of 160 mmHg or over. Of the 42%, only three (12%) had a D.B.P. >90 mmHg, and all three were <105 mmHg. Of the 58% with systolic readings <160, only one had a diastolic reading >90, and that was <105. Therefore, 88% of the uncontrolled hypertensives were in the diagnostic category of isolated systolic hypertension in the elderly. For many years the management of systolic hypertension in the elderly was controversial. Recent studies indicate that it is beneficial to treat isolated systolic hypertension equal or above 160 mm Hg.[8, 11, 35, 36] The results suggest that the recommendation to treat such cases had not impacted the cases under review.

7.7.5 Compliance

Hypertensives: 78% were deemed to be compliant.

This value is probably overestimated. The quality of the evidence from chart review was poor. A proper study would have to be designed to study this question. Evans has noted that for hypertensives, 50% no longer receive care after one year of diagnosis. Of those still under care, about a third are non-compliant. Thus as few as 30% may be able to benefit fully from treatment one year after diagnosis.[37] There were no significant differences between the sexes or between those < 60 and ≥ 60.

7.7.6 Target Organ Damage (T.O.D.)

Hypertensives: 39% had evidence of T.O.D.

Women:	≥ 60	41% with T.O.D.
	< 60	0% with T.O.D.

~ significantly higher, with a one-sided p-value = 0.0192 (sig. at 5%)

Hypertensives:	≥ 60	46% with T O.D.
	< 60	24% with T.O.D.

~ significantly higher, with a one-sided p-value = 0.0489 (sig. at 5%)

< 60 Years Old:	men	38% with T.O.D.
	women	0% with T.O.D.

~ significantly higher, with a one-sided p-value = 0.0452 (sig. at 5%)

In this clinic, T.O.D. was not present in women under the age of 60 years. Hypertensive men (≥ 60) had a prevalence of T.O.D. of 52%. Note: The chart assessors were unable to determine the T.O.D. status of 21% of patients with hypertension. This makes the results somewhat unreliable.

7.7.7 Management Compared to Other Reports

The *Canadian B.P. Survey*[32] and *Birkett et al's* study[38] do not include the group of patients with diagnosed hypertensiion who are not given medication and whose B.P. is controlled. They both include a group of patients who have elevated B.P. but who are undiagnosed and unaware of their condition. This review reports only on diagnosed hypertension. The proportions are reworked for comparison.

	S.F.H.C.	B.P. SURVEY[32]	BIRKETT[38]
Prevalence of Hypertension	18%[(a)]	18%[(b)]	11.4%[(c)]
Diagnosed HTN: treated & controlled	52 (58%)	233 (67%)	499 (75%)
Diag. HTN: treated & uncontrolled	27 (30%)	86 (25%)	119 (18%)
Diag. HTN: untreated & uncontrolled	11 (12%)	27 (8%)	44 (7%)
Total	90 (100%)	346 (100%)	662 (100%)
Diag. HTN: treated & uncontrolled as a % of those treated.	27/79 (34%)	86/319 (27%)	119/618 (19%)

Note: (a) Including untreated & controlled hypertensives. If excluded, the prevalence would be 16.5% (90/545)

(b) D.B.P. ≥ 90 and/or medication, restricted salt and/or specific weight reduction.

(c) D.B.P. ≥ 90, or on medication.

8. Summary of Key Results (Overall Audit)

Patient Visits

- 70 % of the practice (women 75%; men 64%) is seen at least once in the previous year.
- 84% of the practice is seen in two years and 96% in five years.
- An estimated value (for all age groups) of 75% of women are seen at least once in the previous year. There is an observed peak of 83% during child-bearing and child-rearing ages (30-34 age group).
- 60% of men at age 20 were seen in the preceding year and this percentage gradually increased to 75% at age 74.
- For all patients, an average of 3.4 visits (women 3.9; men 2.9) were made in a year. However, if only those patients who attended at least once were considered then the average number of visits is 4.8/year.
- The average number of visits for those under 30 years was less than 2/year for men and just over 3/year for women. There was a peak at the 25-29 age group of 4.7 for women and 2.4 for men.
- For the 60-64 age group, women made 5.35 visits and men 5.93 visits.
- In the previous year, 30% of the practice made no visits; 23% made 1-2 visits; 38% made 3-9 visits; and 8% made 10+ visits.
- 70% of the practice accounted for 100% of all visits.

- Among the heavier users, 27% of the practice accounted for 70% of all visits.
- Those who on average visited less than 12 times, saw no more than five different care providers. There are potentially 32 providers in a year.
- In the previous five years, no B.P. was recorded in 20% of the practice; (men 29%; women 12%)

B.P. Recording

- No B.P. was recorded at all in 13% of the practice (men 19%; women 8%).
- In the previous 5 years, at age 20, estimates of 54% of men and 18% of women did not have their B.P. recorded; at age 40, 30% men, 14% women; and at 68, 9% for both men and women.
- After one year, only 44% of the practice had their B.P. taken; within two years, 61%; and within five years, 80%.

Hypertension Prevalence

- Hypertension was diagnosed in 18% of the practice (men 20%; women 17%).
- There were no hypertensives under 30 years old; at age 40, less than 10%; at age 60 about 30%; and at age 70, about 50%.
- While at age 45, the estimated prevalence of diagnosed hypertension was 15% for men, and 10% for women, The prevalence of raised B.P. readings was the same (15% and 10% respectively). At age 70, 50% men and 46% women were diagnosed with hypertension, but only 14% had raised B.P. readings. Relatively more had become hypertensive.
- Among hypertensives, 60% were ≥ 60 years, and 52% were women.

Hypertension Management

- 74% of hypertensives were treated.
- 38% of hypertensives (treated and untreated) were not controlled.
- Of those treated, 34% were not controlled
- The uncontrolled rate for women < 60 years was 20%, but was 47% for women ≥ 60 years.
- For those < 60 years, the uncontrolled rate for women was 20%, while the rate for men was 43%.
- The uncontrolled rate for the treatment group was 34% but was 52% for the untreated.
- For those ≥ 60 years, the uncontrolled rate was 36% for those treated and 78% for the untreated.
- For those ≥ 60 years, with uncontrolled hypertension, 88% were in the category of isolated systolic hypertension.

SECTION C: DISCUSSION

The prevalence of hypertension in this practice was 18%, which was higher than the provincial prevalence (15%).[22] At age 45, the estimated prevalence of hypertension was 15% for men and 10% for women. The prevalence of raised B.P. recordings was the same. However, the differences between the proportions with hypertension and elevated B.P. narrows with advancing age. At age 70, 50% men and 46 % women were hypertensive but only 14% had raised B.P. readings, using fitted values. A hypothesis that could account for the *relative* reduction in raised B.P., is that members of this group became hypertensive. Joffres has noted that for Canada, while 15% had hypertension, an equal proportion had elevated B.P. on some (if not all) occasions.[16] Also mild hypertension progresses to more serious elevations.[17] This observation appears consistent with the natural history of hypertension and that elevated B.P. progresses to hypertension in later years.

The prevalence of hypertension rose dramatically with age. There were no patients with hypertension below the age of 30. The prevalence progressively rose to 50% at age 70. Among patients diagnosed with hypertension (treated and untreated), 38% were uncontrolled. Of those treated, 34% were uncontrolled. The latter was higher than reported in other studies (27% & 19%).[32,38] The uncontrolled rate for those ≥ 60 years was 36% for those treated and 78% for those untreated. Most (88%) of the uncontrolled hypertension in the ≥ 60 years–group was isolated systolic hypertension. In particular, women ≥ 60 years had an uncontrolled rate of 47% compared with 20% for those < 60. It appears that the practice did not have a consistent practice policy for the management of I.S.H. (isolated systolic hypertension) in the elderly. Women were particularly affected. For those < 60 years, the uncontrolled rate for men was 43% compared to 20% for women. Strategies of improved surveillance and management are needed for men of this age group.

The implementation of health maintaining interventions for men appears problematic. While 75% of women attended at least once in the previous year, only 64% of men attended. Women attended much more (83%) during their child-bearing and child-rearing age. They visit more often, 3.9 visits/year compared to 2.9/year for men; and during child-rearing age, 4.7/year for women. While women attend for health maintenance such as breast examination, Pap smears, contraception, and hormonal replacement at menopause, there are no significant gender specific interventions for men. In addition, women become more accustomed to the health care system, come with their children, and have more opportunity to ask questions, and have more know-how to access services when they think of it. For these reasons, opportunistic interventions are carried out more with women than with men. This is well-illustrated with the taking of a blood pressure.

Overall, 13% of patients never had their B.P. recorded, 19% of men didn't, compared to only 8% of women. In the previous five years, while 20% of patients did not have their B.P. taken, the rate for men was 29%, and women 12%. In the same period of time, at age 20, 54% men and 18% women did not have their B.P. taken; and at age 40, 30% men and 14% women. In the previous year only 44% of patients had their B.P. taken; within two years, 61% and within five years, 80%. The one-year rate of 44% is lower than the 70-75% reported by others.[29, 32, 33] Dunn reported that 83% of patients who visited their doctor in two years, had their B.P. taken.[34]

While for Canadians, 82% visited their G.P. in a year, 70% of patients in this clinic attended at least once in the year.[22] However, there is a turnover of 84% in two years and 96% in five years. Therefore, in general, opportunistic interventions could be run at two or five year cycles and effectively achieve coverage of 84% and 96% of patients respectively. Of significance is the unequal distribution of services to the patients with a heavy burden of illness. 70% of patients used 100% of the services (visits) in a year; and 27% of patients accounted for 70% of all visits.

Generally, this audit has demonstrated the ability to obtain very useful information about the behaviour of both patients and providers, of the prevalence of an identified disease and its management.

SECTION D: RECOMMENDATIONS

1. The outside of charts of patients with hypertension be recognizably flagged. This would facilitate identification for management and for audit.

2. Use a hypertension flow chart (*Appendix G*). The flow chart will facilitate adequate documentation for management and for future audit.

3. Use the treatment protocols developed by the *Canadian Consensus on Hypertension Management 1984-1992* (on the reverse of the flow chart described in #2). This will facilitate consistency of care and will guide the choices for effective management.

4. Identify patients at risk for coronary artery disease, by using the *CAD Risk Prediction Chart* included in (*Appendix H*). This would effect a rational assessment of whether to treat discretionary levels of diastolic hypertension. The risk assessment should be discussed with patients to increase their involvement in their own care (e.g. what it would mean in terms of risk reduction if they quit smoking, reduced their cholesterol level, and controlled their B.P.). Concrete goals would then be provided for both patient and provider.

5. Place a reminder poster in each treatment room, such as *"Did you have your pressure checked today?"* If it is needed, then it can be done. Hence a young male, attending the clinic for a sprain might provide the only opportunity for the year to have his B.P. checked.

6. Patients with a casual raised B.P. reading (e.g. within range 155/90) should be re-checked in 6 months.

7. Follow the protocol and treat I.S.H. in the elderly.

8. Institute regular quarterly hypertension flow chart *review* (e.g. 12 charts), randomly selected from those with diagnosed hypertension. This will maintain and reinforce effort and effectiveness.

9. Conduct yearly flow chart audits of randomly selected charts (e.g. 50 hypertensives).

10. Conduct a similar audit to this one on hypertension, on another significant area e.g. Diabetes Mellitus, Depression, Menopausal Hormonal Replacement.

APPENDIX

Appendix A. Sample Questionnaire

Chart #										
1. Age: (enter yrs.)										
20–29										
30–39										
40–49										
50–59										
60–69										
70+										
2. Sex:										
male										
female										
3. Visits										
> 2 yrs.										
2 yrs. at least 1										
1 yr. 1										
2										
3										
4										
5+										
4. Providers										
1										
2										
3										
4										
5+										
5. BP recorded:										
SBP										
DBP										
Year BP recorded										
> 2 yrs.										
2 yrs. at least 1										
1 yr. at least 1										
6. Hypertensives:										
HTN diagnosed										
Elevated BP:										
Any DBP =/> 90										
and/or if =/> 60 yrs: Isolated SBP										
≥ 160										
7. BP Control										
DBP < 90										
90–99										
100–104										
≥105										
SBP <140										
140–159										
≥160										
8. Target Organ Damage:										
TOD present										
TOD absent										
Don't Know										
9. Treatment Decision:										
HTN – Treated										
HTN – Not Treated										
10. Patient Compliance:										
Drug Repeats appropriate										
Drug Repeats inappropriate										
Copmpliance Noted 'Good'										
Compliance Noted 'Poor'										
Don't Know										

Appendix B. Stratified Sampling

Definition

A stratified random sample is one obtained by separating the population of interest into non-overlapping groups (strata), and then selecting a random sample from each stratum.[39] The following is a summary of the principal reasons for using a stratified sampling technique:

(1) Stratification may produce a smaller bound on the error of estimation than would be produced by a simple random sample of the same size.
(2) The cost per observation in the survey may be reduced by stratification of the population into convenient groups.
(3) Estimates of population parameters may be desirable for subgroups of the population.[39]

Sampling

The first step in stratified sampling is to clearly specify the strata. Once this is done, a random sample from each stratum is selected. The most appropriate allocation scheme is affected by three factors:

(1) The total number of elements in each stratum
(2) The variability of observations within each stratum
(3) The cost of obtaining an observation from each stratum[39]

There are formulas that take into account all three of the above factors.[39] However, the most common sampling is by means of proportional allocation, where the sample sizes from each stratum are proportional to the stratum sizes. The main advantage to this allocation is that the sample is representative of the population of interest. Proportional allocation can be used under the following circumstances:

(1) The cost of obtaining an observation is the same for all strata, or the costs are negligible.
(2) The variances for each stratum are approximately equal, or no information is available concerning the variance for the strata.[39]

Estimation of a Population Mean

Denote:

L = number of strata

N_i = number of sampling units in stratum i

N = number of sampling units in the population

n_i = sample size for stratum i

n = sample size

μ_i = population mean for stratum i

μ = true population mean

$\bar{y}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} y_{ij}$ = sample mean for stratum i

σ_i^2 = population variance for stratum i

$s_i^2 = \frac{1}{n_i - 1}\sum_{j=1}^{n_i}\left(y_{ij} - \bar{y}_i\right)^2$ = sample variance for stratum i

$\bar{y}_{st}$ = estimator of the population mean from stratified random sampling

Estimator of the Population Mean:[39]

$$\bar{y}_{st} = \frac{1}{N}\left[N_1\bar{y}_1 + N_2\bar{y}_2 + \cdots + N_L\bar{y}_L\right] = \frac{1}{N}\sum_{i=1}^{L} N_i\bar{y}_i$$

Estimated Variance:[39]

$$\hat{V}(\bar{y}_{st}) = \frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{s_i^2}{n_i}\right)$$

Bound on the Error of Estimation:

$$1.96\sqrt{\hat{V}(\bar{y}_{st})} = 1.96\sqrt{\frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{s_i^2}{n_i}\right)}$$

95% Confidence Interval for the True Population Mean:

$$\bar{y}_{st} \pm 1.96\sqrt{\hat{V}(\bar{y}_{st})} = \frac{1}{N}\sum_{i=1}^{L} N_i\bar{y}_i \pm 1.96\sqrt{\frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{s_i^2}{n_i}\right)}$$

Estimation of a Population Proportion

Denote:

L = number of strata

N_i = number of sampling units in stratum i

N = number of sampling units in the population

n_i = sample size for stratum i

n = sample size

y_{ij} = 0 if the jth element for stratum i does not possess the specified characteristic

= 1 if the jth element for stratum i possesses the specified characteristic

p_i = population proportion for stratum i

p = true population proportion

$\hat{p}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} y_{ij}$ = sample proportion for stratum i

$\hat{q}_i = 1 - \hat{p}_i$

$\hat{p}_{st}$ = estimator of the population proportion from stratified random sampling

Estimator of the Population Proportion:[39]

$$\hat{p}_{st} = \frac{1}{N}\left[N_1\hat{p}_1 + N_2\hat{p}_2 + \cdots + N_L\hat{p}_L\right] = \frac{1}{N}\sum_{i=1}^{L} N_i\hat{p}_i$$

Estimated Variance:[39]

$$\hat{V}(\hat{p}_{st}) = \frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{\hat{p}_i\hat{q}_i}{n_i - 1}\right)$$

Bound on the Error of Estimation:

$$1.96\sqrt{\hat{V}(\hat{p}_{st})} = 1.96\sqrt{\frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{\hat{p}_i\hat{q}_i}{n_i - 1}\right)}$$

95% Confidence Interval for the True Population Proportion:

$$\hat{p}_{st} \pm 1.96\sqrt{\hat{V}(\hat{p}_{st})} = \frac{1}{N}\sum_{i=1}^{L} N_i\hat{p}_i \pm 1.96\sqrt{\frac{1}{N^2}\sum_{i=1}^{L} N_i^2\left(\frac{N_i - n_i}{N_i}\right)\left(\frac{\hat{p}_i\hat{q}_i}{n_i - 1}\right)}$$

The Risk Difference

The risk difference is simply the difference between two proportions from independent samples. This statistic is often described in terms of the difference in probability of developing a disease for exposed and unexposed individuals, in the medical literature.[40] A point estimate and a 95% confidence interval for the risk difference can be calculated from two stratified random samples, using a normal approximation to the binomial distribution.[40] If the 95% C.I. does not contain 0, it can be concluded that there is a significant (*p*-value <0.05) difference between the two proportions.

Denote:

p_1 = population proportion for Group 1

p_2 = population proportion for Group 2

$\Delta = p_1 - p_2$ = Risk Difference

$\hat{p}_{1st} = \frac{1}{N_1}\sum_{i=1}^{L_1} N_{1i}\hat{p}_{1i}$ = estimator of the population proportion for Group 1

$\hat{p}_{2st} = \frac{1}{N_2}\sum_{i=1}^{L_2} N_{2i}\hat{p}_{2i}$ = estimator of the population proportion for Group 2

Estimator of the Risk Difference:[39,40]

$$\hat{\Delta} = \hat{p}_{1st} - \hat{p}_{2st} = \frac{1}{N_1}\sum_{i=1}^{L_1} N_{1i}\hat{p}_{1i} - \frac{1}{N_2}\sum_{i=1}^{L_2} N_{2i}\hat{p}_{2i}$$

Estimated Variance:[39,40]

$$\hat{V}\left(\hat{\Delta}\right) = \frac{1}{N_1^2}\sum_{i=1}^{L_1} N_{1i}^2\left(\frac{N_{1i}-n_{1i}}{N_{1i}}\right)\left(\frac{\hat{p}_{1i}\hat{q}_{1i}}{n_{1i}-1}\right) + \frac{1}{N_2^2}\sum_{i=1}^{L_2} N_{2i}^2\left(\frac{N_{2i}-n_{2i}}{N_{2i}}\right)\left(\frac{\hat{p}_{2i}\hat{q}_{2i}}{n_{2i}-1}\right)$$

Bound on the Error of Estimation:

$$1.96\sqrt{\hat{V}\left(\hat{\Delta}\right)} = 1.96\sqrt{\frac{1}{N_1^2}\sum_{i=1}^{L_1} N_{1i}^2\left(\frac{N_{1i}-n_{1i}}{N_{1i}}\right)\left(\frac{\hat{p}_{1i}\hat{q}_{1i}}{n_{1i}-1}\right) + \frac{1}{N_2^2}\sum_{i=1}^{L_2} N_{2i}^2\left(\frac{N_{2i}-n_{2i}}{N_{2i}}\right)\left(\frac{\hat{p}_{2i}\hat{q}_{2i}}{n_{2i}-1}\right)}$$

95% Confidence Interval for the True Risk Difference:

$$\left(\hat{p}_{1st} - \hat{p}_{2st}\right) \pm 1.96\sqrt{\frac{1}{N_1^2}\sum_{i=1}^{L_1} N_{1i}^2\left(\frac{N_{1i}-n_{1i}}{N_{1i}}\right)\left(\frac{\hat{p}_{1i}\hat{q}_{1i}}{n_{1i}-1}\right) + \frac{1}{N_2^2}\sum_{i=1}^{L_2} N_{2i}^2\left(\frac{N_{2i}-n_{2i}}{N_{2i}}\right)\left(\frac{\hat{p}_{2i}\hat{q}_{2i}}{n_{2i}-1}\right)}$$

Appendix C. Multiple Linear Regression

Introduction

Suppose that there is a dependent variable or response y that depends on k independent or regressor variables, x_1, x_2, ..., x_k. The relationship between these variables is characterized by a mathematical model called a regression equation.[41] The model

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon \quad (\varepsilon = \text{ random error})$$

is fitted using multiple linear regression analysis. Clearly, y is linearly dependent on the k regressor variables. This model describes a hyperplane in the k-dimensional space of the regressor variables.[41]

Fitting the Model

Suppose that $n > k$ observations are available, and let x_{ij} denote the jth observation of variable x_i.The estimation procedure requires that the random error component have

$$E(\varepsilon) = 0 \quad \text{and} \quad Var(\varepsilon) = \sigma^2 \quad .$$

The model can be written in terms of the data as

$$y_j = \beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j} + \cdots + \beta_k x_{kj} + \varepsilon_j \quad j = 1, 2, \ldots, n \quad ,$$

which can be alternately expressed as

$$y_j = \beta_0' + \sum_{i=1}^{k} \beta_i \left(x_{ij} - \bar{x}_i \right) + \varepsilon_j \quad j = 1, 2, \ldots, n \quad ,$$

$$\text{where } \bar{x}_i = (1/n) \sum_{j=1}^{n} x_{ij} \quad \text{and} \quad \beta_0' = \beta_0 + \beta_1 \bar{x}_1 + \beta_2 \bar{x}_2 + \cdots + \beta_k \bar{x}_k \quad .$$ [41]

The least squares function is defined as

$$L = \sum_{j=1}^{n} \left[y_i - \beta_0' + \sum_{i=1}^{k} \beta_i \left(x_{ij} - \bar{x}_i \right) \right]^2 \quad .$$ [41]

The least square estimates for the unknown regression coefficients are chosen such that the above least square function is minimized. Note: For the purpose of this project, the finite population nature of the sample will be ignored, thus a standard regression analysis will be applied.

Parameter Estimation

The model may be written in matrix notation as:

$$\mathbf{Y} = \mathbf{XB} + \mathbf{e} \quad ,$$

where

$$\mathbf{Y} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}_{n\times 1} \quad \mathbf{X} = \begin{bmatrix} 1 & (x_{11} - \bar{x}_1) & \cdots & (x_{k1} - \bar{x}_k) \\ 1 & (x_{12} - \bar{x}_1) & \cdots & (x_{k2} - \bar{x}_k) \\ \vdots & \vdots & \vdots & \vdots \\ 1 & (x_{1n} - \bar{x}_1) & \cdots & (x_{kn} - \bar{x}_k) \end{bmatrix}_{n\times(k+1)} \quad \mathbf{B} = \begin{bmatrix} \beta_0' \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix}_{(k+1)\times 1} \quad \text{and} \quad \mathbf{e} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}_{n\times 1} \quad .$$

The least square estimator of **B** is

$$\hat{\mathbf{B}}_{(k+1)\times 1} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y} \quad .^{41}$$

The regression model would therefore be

$$\hat{y} = \hat{\beta}_0' + \hat{\beta}_1(x_1 - \bar{x}_1) + \hat{\beta}_2(x_2 - \bar{x}_2) + \cdots + \hat{\beta}_k(x_k - \bar{x}_k) \quad .$$

Testing the Significance of the Coefficients

The hypotheses for testing the significance of any individual coefficient are

$$H_0: \beta_i = 0 \quad vs. \quad H_1: \beta_i \neq 0 \quad i = 0, 1, \ldots, k \quad .$$

The least squares estimator of **B** is a random variable with a multivariate normal distribution. The distribution is

$$\hat{\mathbf{B}} \sim N_{k+1}\left[\mathbf{B}, \sigma^2(\mathbf{X}'\mathbf{X})^{-1}\right] \quad .^{41}$$

Therefore, each regression coefficient has the distributional property

$$\hat{\beta}_i \sim N\left[\beta_i, \sigma^2\{(i+1)st \text{ diagonal element of } \mathbf{X}'\mathbf{X}\}\right] \quad .$$

Under the null hypothesis that the individual coefficient equals zero, the test statistic (t-ratio)

$$\hat{\beta}_i \Big/ \sqrt{\tilde{\sigma}^2 d_i}$$

has a t-distribution with n-(k+1) degrees of freedom, where

$$\tilde{\sigma}^2 = \left(\mathbf{Y'Y} - \hat{\mathbf{B}}'\mathbf{X'Y}\right) \Big/ (n-k-1) \quad \textit{and} \quad d_i = (i+1)st \text{ diagonal element of } \mathbf{X'X}$$.[41]

Most computer packages provide the parameter estimates, estimated standard deviations, t-ratios, and p-values. A wise procedure is to fit the full model (i.e. including all regressor variables), and then observe which parameters are not significant. The least significant (p-value < 0.05 or 0.10) parameter can be removed, and the model can be re-fitted with k-1 independent variables. This procedure can be repeated until there are only significant regressor (explanatory) variables left in the model. Note: No joint inferences on regression coefficients are made in this project.

Appendix D. Logistic Regression

For the purpose of this project, the finite population nature of the sample will be ignored, thus a standard logistic regression analysis will be applied.

Fitting Linear Models to Binomial Data

For Binomial data, the response from the *ith* unit, $i = 1,2,\ldots, N$, is the proportion y_i/n_i; for binary data, $n_i = 1$, and $y_i = 0$ (failure) or $y_i = 1$ (success). Here y_i is Binomial(n_i, p_i), where p_i is the probability of success at the *ith* level. In this situation, we wish to explore the relationship between p_i and the observed, measurable, and independent variables. One approach may be to use what we know about linear regression analysis, and use a model such as

$$p_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} \quad ,$$

and use the least squares method to obtain estimates for the unknown parameters. Clearly, p_i depends linearly on the k explanatory variables labelled x_1, $x_2,\ldots,x_k$, through unknown parameters

$$\beta_0, \beta_1, \ldots, \beta_k \quad .$$

There are several drawbacks to this strategy:

(1) Since y_i has a binomial distribution, $Var(y_i)$ is not constant over each of the N units.[42]

(2) Linear regression analysis involves an assumption of normality; here this assumption does not hold. However, when the n_i's are large, the normal distribution is the limiting distribution of the binomial distribution.[42]

(3) A final difficulty arises in the fitted values, p_i, under the model. The beta's are unconstrained; it is therefore conceivable that certain fitted values may not lie in the interval (0, 1), which would be inconsistent with the laws of probability.[43]

A simple and effective way to avoid problem (3) is to use a transformation that maps the unit interval onto the whole real line. A commonly used transformation (link function) is the logistic function $g(p)$.

$$g(p) = \log\{p/(1-p)\}$$

Note: As $p \to 0$, $g(p) \to -\infty$; as $p \to 1$, $g(p) \to \infty$; and when $p = 0.5$, $g(p) = 0$.

The Linear Logistic Model

Suppose we have N observed proportions of success of the form y_i/n_i, $i = 1, 2, \ldots, N$, and p_i is the probability of success corresponding to the ith observed proportion. The linear logistic model with k covariates is:

$$\text{logit}(p_i) = \log\{p_i/(1-p_i)\} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} = \eta_i$$

It will be assumed that this relationship holds at least in the range of the explanatory variables considered. This expression can alternately be written in terms of the probability of success:

$$p_i = \frac{\exp(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki})}{1 + \exp(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki})} = \frac{e^{\eta_i}}{1 + e^{\eta_i}}$$

Parameter Estimation

To fit the linear logistic model, the method of maximum likelihood is used to estimate the unknown parameters

$$\beta_0, \beta_1, \ldots, \beta_k \quad .$$

The likelihood function is given by

$$\text{Define: } \mathbf{p} = \{p_1, p_2, \ldots, p_N\}; \ \mathbf{y} = \{y_1, y_2, \ldots, y_N\}$$

$$L(\mathbf{p}; \mathbf{y}) = \prod_{i=1}^{N} \binom{n_i}{y_i} p_i^{y_i} (1 - p_i)^{n_i - y_i} \quad .$$

The log-likelihood function is given by

$$l(\mathbf{p}; \mathbf{y}) = \sum_{i=1}^{N} \left\{ \log\binom{n_i}{y_i} + y_i \log\left(\frac{p_i}{1-p_i}\right) + n_i \log(1 - p_i) \right\}; \ \log\left(\frac{p_i}{1-p_i}\right) = \eta_i \quad .$$

Substituting the identity into the function yields

$$l(\mathbf{B}; \mathbf{y}) = \sum_{i=1}^{N} \left\{ \log\binom{n_i}{y_i} + y_i \eta_i - n_i \log(1 + e^{\eta_i}) \right\} \quad .$$

The derivatives of this function with respect to the k+1 unknown parameters are

$$\frac{\partial l}{\partial \beta_r} = \sum_{i=1}^{N} y_i x_{ri} - \sum_{i=1}^{N} n_i x_{ri} e^{\eta_i} / (1 + e^{\eta_i}), \quad r = 0,1,\ldots,k \quad x_{0i} = 1 \text{ for all } i \ .$$

Setting these derivatives to zero and solving for the beta's results in a system of k+1 unknowns in k+1 equations. This can only be solved numerically (i.e. with some computer package). A more straightforward approach would be to use Fisher's Method of scoring to obtain the maximum likelihood estimates.[42] This procedure is described as follows:

The above derivative can alternately be expressed in vector notation as

$$\partial l / \partial \mathbf{B} = \mathbf{X}^T (\mathbf{Y} - \mathbf{M}), \quad \text{where:}$$

$$\partial l / \partial \mathbf{B}^T = [\partial l / \partial \beta_0, \partial l / \partial \beta_1, \ldots, \partial l / \partial \beta_k],$$

$$\mathbf{Y}^{\mathrm{T}} = [y_1, y_2, \ldots, y_N], \quad \mathbf{M}^{\mathrm{T}} = [n_1 p_1, n_2 p_2, \ldots, n_N p_N] \quad p_i = e^{\eta_i} / (1 - e^{\eta_i}),$$

$$\mathbf{X} = \begin{bmatrix} 1 & x_{11} & \cdots & x_{k1} \\ 1 & x_{12} & \cdots & x_{k2} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & x_{1N} & \cdots & x_{kN} \end{bmatrix}_{N \times k+1}, \quad \text{and } \mathbf{B}^T = [\beta_0, \beta_1, \ldots, \beta_k] \ .^{43}$$

The Fisher information for **B** is

$$-E\left(\frac{\partial^2 l}{\partial \beta_r \partial \beta_s}\right) = \left\{\mathbf{X}^T \mathbf{W} \mathbf{X}\right\}_{rs} \ ,$$

where **W** is a diagonal matrix of weights given by

$$\mathbf{W} = \operatorname{diag}\left\{n_i p_i (1 - p_i)\right\} \ .^{43}$$

Using the Newton-Raphson procedure, estimates may be obtained iteratively:

Given initial estimates $\hat{\mathbf{B}}_0$, the vectors $\hat{\mathbf{p}}_0$ and $\hat{\mathbf{M}}_0$ can be computed.

Using these values, define the adjusted dependent variate, **Z**, with components

$$z_i = \hat{\eta}_i + \frac{y_i - n_i \hat{p}_i}{n_i} \left(\frac{d\eta_i}{dp_i}\right) \ .^{43}$$

Maximum likelihood estimates satisfy the equation

$$\mathbf{X}^T\mathbf{W}\mathbf{X}\hat{\mathbf{B}} = \mathbf{X}^T\mathbf{W}\mathbf{Z}$$

which can be solved iteratively using standard least squares methods.[43] The revised estimate is

$$\hat{\mathbf{B}}_1 = \left(\mathbf{X}^T\mathbf{W}\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{W}\mathbf{Z} \quad ,$$

where all quantities on the right are computed using the initial estimate.[43] This algorithm can be found in a number of computer packages (GLIM, Genstat, SAS, BMDP, SPSS, EGRET, and GLMStat). Once the parameters have been estimated, the estimated model is

$$\hat{\eta}_i = \hat{\beta}_0 + \hat{\beta}_1 x_{1i} + \hat{\beta}_2 x_{2i} + \cdots + \hat{\beta}_k x_{ki} \quad .$$

From this, the fitted probabilities can be calculated from

$$\hat{p}_i = \frac{e^{\hat{\eta}_i}}{1 + e^{\hat{\eta}_i}} \quad .$$

Goodness of Fit

A natural sequel to model fitting is to test how *close* the fitted values are to the observed values. This closeness or goodness of fit can be determined by calculating the residual deviance. This deviance is defined to be twice the difference between the maximum achievable log-likelihood (the full or saturated model) and the log-likelihood attained from the fitted model (current or simpler model). In model fitting, it is always desirable to have the simplest model possible (i.e. fewest independent variables) which still yields good estimates. Under the full model, the fitted probabilities will simply be the observed proportion y_i/n_i, for $i = 1,2,\ldots, N$. The maximum log-likelihood function is

$$l(\tilde{\mathbf{p}};\mathbf{y}) = \sum_{i=1}^{N}\left\{\log\binom{n_i}{y_i} + y_i \log \tilde{p}_i + (n_i - y_i)\log(1-\tilde{p}_i)\right\}, \quad \text{where } \tilde{p}_i = y_i/n_i \quad .$$

The maximum log-likelihood function under the fitted (simpler) model, using the M.L. estimates is

$$l(\hat{\mathbf{p}};\mathbf{y}) = \sum_{i=1}^{N}\left\{\log\binom{n_i}{y_i} + y_i \log \hat{p}_i + (n_i - y_i)\log(1-\hat{p}_i)\right\} \quad .$$

The deviance function is therefore

$$D(\mathbf{y};\hat{\mathbf{p}}) = 2\left[l(\tilde{\mathbf{p}};\mathbf{y}) - l(\hat{\mathbf{p}};\mathbf{y})\right]$$

$$D(\mathbf{y};\hat{\mathbf{p}}) = 2\sum_{i=1}^{N}\left\{y_i \log\left(\frac{\tilde{p}_i}{\hat{p}_i}\right) + (n_i - y_i)\log\left(\frac{1-\tilde{p}_i}{1-\hat{p}_i}\right)\right\} ,$$

This deviance is a measure of lack of fit; the greater the value, the greater the lack of fit, for a given degrees of freedom. The deviance is asymptotically or approximately distributed as chi-square with N-q degrees of freedom, where q is the number of fitted parameters (q less than or equal to k). Proofs of the limiting chi-square distribution are dependent on the following assumptions:

(1) The observations are independently distributed.[43]

(2) The approximation is based on a limiting operation where N is fixed, and

$$n_i \to \infty \text{ for each } i, \text{ and } n_i p_i(1-p_i) \to \infty \quad .^{43}$$

If either of these assumptions fail to hold, the limiting chi-square approximation no longer holds. Thus, the deviance is most useful not as an absolute measure of goodness of fit, but for comparing two models. This will be discussed shortly. It is therefore essential to assess whether the two assumptions are valid. Since the approximation may not be adequate, this goodness of fit should be used with caution.[42]

Comparing Linear Logistic Models

The deviance can be used to compare alternative linear logistic models, where one model contains terms that are additional to those in another (i.e. two *nested* models). The reduction in deviance measures the extent to which the additional terms improve the fit to the response variable. Suppose we want to compare Model (1) and Model (2), where Model (2) has an additional covariate x_j. The reduction in deviance is

$$D_1(\mathbf{y};\hat{\mathbf{p}}) - D_2(\mathbf{y};\hat{\mathbf{p}}) = 2\left[l(\tilde{\mathbf{p}};\mathbf{y}) - l_1(\hat{\mathbf{p}};\mathbf{y})\right] - 2\left[l(\tilde{\mathbf{p}};\mathbf{y}) - l_2(\hat{\mathbf{p}};\mathbf{y})\right]$$

$$D_1(\mathbf{y};\hat{\mathbf{p}}) - D_2(\mathbf{y};\hat{\mathbf{p}}) = -2\left[l_1(\hat{\mathbf{p}};\mathbf{y}) - l_2(\hat{\mathbf{p}};\mathbf{y})\right] ,$$

which can alternately be written

$$D_1(\mathbf{y};\hat{\mathbf{p}}) - D_2(\mathbf{y};\hat{\mathbf{p}}) = 2\sum_{i=1}^{N}\left\{y_i \log\left(\frac{\hat{p}_{2i}}{\hat{p}_{1i}}\right) + (n_i - y_i)\log\left(\frac{1-\hat{p}_{2i}}{1-\hat{p}_{1i}}\right)\right\} \quad .$$

This statistic is approximately distributed chi-square with 1 d.f., and a ***p***-value can be calculated. If Model (2) had 2 additional covariates, the corresponding degrees of freedom would be 2. Denote the deviance under each model D_1 and D_2,with ν_1 and ν_2 degrees of freedom respectively. In general, the reduction in deviance D_1-D_2 will have an approximate chi-square distribution with ν_1-ν_2 degrees of freedom. The chi-square approximation is quite accurate for differences in deviations, even though it may be inaccurate for the deviances themselves.[42,43]

Testing the Significance of the Coefficients

The method for testing the significance of the coefficient of a variable follows a similar approach to that used in linear regression, but uses the likelihood function instead. The *Wald* test is obtained by calculating the ratio

$$\hat{\beta}_j \big/ s.e.\left(\hat{\beta}_j\right), \quad j = 0,1,\ldots,k \quad .$$

Under the null hypothesis that the slope coefficient equals zero, the ratio has a standard normal distribution, as opposed to a *t*-distribution for linear regression.[44] Most computer packages provide the standard error of the estimated parameter, the *t*-ratio, and the ***p***-value. The assumptions needed for this test are the same as those for the deviance.

The covariance matrix for the **B** estimates can also be estimated. If the model is correct, the estimated matrix is then

$$\mathbf{C} = \text{estimated } \mathrm{cov}\left(\hat{\mathbf{B}}\right) = \tilde{\sigma}^2\left(\mathbf{X}^T\mathbf{W}\mathbf{X}\right)^{-1} \quad ,$$

$$\text{where } \tilde{\sigma}^2 = \frac{1}{N-q}\sum_{i=1}^{N}\frac{\left(y_i - n_i\hat{p}_i\right)^2}{n_i\hat{p}_i\left(1-\hat{p}_i\right)} \quad .^{43}$$

Note: $\tilde{\sigma}^2$ is Pearson's χ^2 statistic, divided by $(N - \#\,\text{fitted parameters})$.

From **C**, the standard error for the *i*th estimate is simply the square root of the ith diagonal entry, i.e. $c_{ii}^{1/2}$. Note: In this project, the joint inference of regression parameters is not explored.

Appendix E. 2 x 2 Contingency Table Analysis

Introduction

A 2 x 2 contingency table is a table composed of two rows and two columns. The values (counts) in the four cells are contingent (dependent) on the marginal totals.[45]

	+	−	
Group 1	a	b	$n_1 = a + b$
Group 2	c	d	$n_2 = c + d$
	$m_1 = a + c$	$m_2 = b + d$	

This is an appropriate way to display data that can be classified by two different variables, each of which has only two possibilities.[40] The two row totals are denoted n_1 and n_2; the two column totals are denoted m_1 and m_2. Contingency tables are often used test whether the two specified variables are independent or dependent (i.e. a significant relationship between the two). The outlined procedure is equivalent to testing the equality of two proportions

$$p_{success:\,group\,1} = p_{success:\,group\,2} .$$

The Odds-Ratio

If the probability of success = p, then the odds in favor of success = $p/(1\text{-}p)$. If two proportions p_1, p_2 are considered and the odds in favor of success are computed for each, then the ratio of odds (odds-ratio) is a useful measure for relating the two proportions.[40] Let p_1, p_2 be the probability of success for two groups. The odds-ratio is defined as

$$OR = \frac{p_1/q_1}{p_2/q_2} = \frac{p_1 q_2}{p_2 q_1} .$$

If the probability of success is the same for the two groups, then the odds-ratio will be equivalent to 1. An odds-ratio higher (or lower) than 1 indicates a greater (or lower) likelihood of success among group 1 than group 2. If the odds-ratio is equal to 1, it can be said that there is no apparent relationship between group and success. Conversely, if the odds-ratio is not close to 1, it can be said that there is a relationship between the two variables, the strength of which depends upon the magnitude of the ratio.

Odds-Ratio Estimation

A point estimate for the true odds-ratio (OR) is given by

$$\hat{OR} = \frac{\hat{p}_1/\hat{q}_1}{\hat{p}_2/\hat{q}_2} = \frac{ad}{bc} .$$

Confidence intervals are computed using the Woolf method, which involves an approximate normal distribution of the natural logarithm of the point estimate.[46] An approximate two-sided 95% confidence interval for the true odds-ratio is given by

$$\left(e^{c_1}, e^{c_2}\right)$$

where

$$c_1 = \ln(\hat{OR}) - 1.96\sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}$$

$$c_2 = \ln(\hat{OR}) + 1.96\sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}} .$$[40]

If the confidence interval does not contain 1, it can be concluded that there is a significant (*p*-value <0.05) difference between the two probabilities of success. Note: for a 90% confidence interval, replace 1.960 with 1.645.

Fisher's Exact Test

An alternate method to test the hypothesis

$$H_0: p_1 = p_2 \quad \text{versus} \quad H_1: p_1 \neq p_2$$

would be to use Fisher's exact test. This test provides exact *p*-values for any 2 x 2 table, with fixed margins. The exact probability of observing a table with cells *a*, *b*, *c*, and *d* is

$$\Pr(a, b, c, d) = \frac{(a+b)!(c+d)!(a+c)!(b+d)!}{n!a!b!c!d!} .$$

Thus, every possible observation (with the fixed margins of n_1, n_2, m_1, and m_2) has a corresponding probability. The ***p***-value (2-tail) for the observed table is calculated as

$$p - \text{value (2 - tail)} \quad = \sum_{\{i:\,\Pr(i) \le \Pr(a)\}} \Pr(i)\,, \quad 0 \le i \le \min\{a+b,\, a+c\} \quad ,$$

where ***i*** is any possible entry in the upper left cell (Note: with fixed margins and one cell entry, all other cells can be found). The ***p***-value (1-tail) for testing the hypothesis H_0: p_1 = p_2 versus H_1: $p_1 > p_2$ is calculated as

$$p - \text{value (1 - tail)} \quad = \sum_{\{i:\,i \ge a\}} \Pr(i)\,, \quad a \le i \le \min\{a+b,\, a+c\} \quad .$$

The ***p***-value (1-tail) for testing the hypothesis H_0: $p_1 = p_2$ versus H_1: $p_1 < p_2$ is calculated as

$$p - \text{value (1 - tail)} \quad = \sum_{\{i:\,i \le a\}} \Pr(i)\,, \quad 0 \le i \le a \quad .$$

For each of these three hypotheses, the ***p***-value can be interpreted as the probability of obtaining a table as or more extreme than the observed table.[40]

Appendix F. Selected Data Summaries

F1. Hypertension Audit Data

COMPLETE SAMPLE (N 629)

Age Group	M	HTN	HBP	EBP	NTN	MEN No BP	WOMEN No BP	NTN	EBP	HBP	HTN	F
20 – 24	34	0	1	1	24	9	7	23	2	2	0	32
25 – 29	31	0	0	0	19	12	1	35	2	2	0	38
30 – 34	49	4	2	6	28	15	5	36	1	1	0	42
35 – 39	37	0	4	4	26	7	4	30	2	1	1	36
40 – 44	36	4	8	12	18	6	2	21	7	4	3	30
45 – 49	20	3	5	8	8	4	2	22	5	1	4	29
50 – 54	19	5	4	9	7	3	1	11	7	2	5	19
55 – 59	22	5	6	11	9	2	3	10	9	3	6	22
60 – 64	14	6	1	7	7	0	0	11	6	0	6	17
65 – 69	21	10	1	11	10	0	0	9	10	0	10	19
70 – 74	16	10	0	10	6	0	0	7	7	3	4	14
75+	9	2	1	3	6	0	1	6	16	4	12	23
TOTAL	308	49	33	82	168	58	26	221	74	23	51	321

SAMPLE: PATIENTS WITH BLOOD PRESSURE RECORDINGS (N 545)

MEN WOMEN

Age		HTN		HBP		EBP					EBP		HBP		HTN		Total
Group	M	#	%	#	%	#	%	NTN	NTN	%	#	%	#	%	#	F	Pts.
20 – 24	25	0	0.00%	1	4.00%	1	4.00%	24	23	8.00%	2	8.00%	2	0.00%	0	25	50
25 – 29	19	0	0.00%	0	0.00%	0	0.00%	19	35	5.41%	2	5.41%	2	0.00%	0	37	56
30 – 34	34	4	11.76%	2	5.88%	6	17.65%	28	36	2.70%	1	2.70%	1	0.00%	0	37	71
35 – 39	30	0	0.00%	4	13.33%	4	13.33%	26	30	6.25%	2	3.13%	1	3.13%	1	32	62
40 – 44	30	4	13.33%	8	26.67%	12	40.00%	18	21	25.00%	7	14.29%	4	10.71%	3	28	58
45 – 49	16	3	18.75%	5	31.25%	8	50.00%	8	22	18.52%	5	3.70%	1	14.81%	4	27	43
50 – 54	16	5	31.25%	4	25.00%	9	56.25%	7	11	38.89%	7	11.11%	2	27.78%	5	18	34
55 – 59	20	5	25.00%	6	30.00%	11	55.00%	9	10	47.37%	9	15.79%	3	31.58%	6	19	39
60 – 64	14	6	42.86%	1	7.14%	7	50.00%	7	11	35.29%	6	0.00%	0	35.29%	6	17	31
65 – 69	21	10	47.62%	1	4.76%	11	52.38%	10	9	52.63%	10	0.00%	0	52.63%	10	19	40
70 – 74	16	10	62.50%	0	0.00%	10	62.50%	6	7	50.00%	7	21.43%	3	28.57%	4	14	30
75+	9	2	22.22%	1	11.11%	3	33.33%	6	6	72.73%	16	18.18%	4	54.55%	12	22	31
TOTAL	250	49	19.60%	33	13.20%	82	32.80%	168	221	25.08%	74	7.80%	23	17.29%	51	295	545

F2. Patients With Diagnosed Hypertension

Data on Patients with Hypertension

ID	AGE	SEX		SBP	DBP	TREAT		CONTROL		TOD			COMPLIANCE	
		M	F			+	-	+	-	+	-	?	+	-
120	30	1		130	95		1	1			1		1	
1719	33	1		130	90	1		1			1		1	
2454	30	1		150	110	1			1		1			1
2481	32	1		140	95		1	1			1		1	
		4				2	2	3	1		4		3	1
2110	39		1	110	85	1		1				1		1
2980	48	1		140	90	1		1			1		1	
3324	44	1		140	96	1			1			1	1	
3400	45	1		146	96	1		1			1		1	
2127	40	1		144	86		1	1				1	1	
1057	49	1		140	85	1		1			1		1	
900	44	1		150	100		1		1			1		1
569	43	1		130	85		1	1				1		1
		7				4	3	5	2		3	4	5	2
3037	47		1	156	96		1	1				1	1	
2089	47		1	165	110	1			1		1		1	
3312	43		1	160	88		1	1			1		1	
2144	41		1	150	90		1	1				1	1	
2485	42		1	114	88	1		1				1	1	
2190	46		1	152	98		1		1			1		1
661	49		1	135	75		1	1			1		1	
969	47		1	135	95		1		1			1		1
			8			2	6	5	3		3	5	6	2
2943	54	1		150	100	1			1	1			1	
3172	55	1		142	95	1			1	1			1	
3223	57	1		140	100		1		1		1		1	
2374	53	1		135	85	1		1		1				1
1120	53	1		150	105	1			1		1			1
1915	59	1		140	82	1		1		1			1	
52	51	1		140	95	1			1	1			1	
353	57	1		150	90	1		1			1		1	
623	57	1		132	82	1		1				1	1	
3287	53	1		152	90	1			1	1			1	
		10				9	1	4	6	6	3	1	8	2
104	53		1	140	75	1		1			1			1
207	53		1	130	90	1		1			1		1	
436	59		1	140	80	1		1			1		1	
564	50		1	150	98	1		1			1		1	
968	58		1	160	80	1		1				1		1
3337	54		1	144	100	1			1			1	1	
1976	55		1	140	80	1		1			1		1	
1998	57		1	130	80	1		1				1	1	
2064	58		1	160	90	1		1				1	1	
2249	58		1	140	90	1		1			1		1	
1700	54		1	130	88	1		1				1		1
			11			11		10	1		6	5	8	3
2486	60		1	162	100	1			1		1			1
3189	62		1	170	90	1			1			1	1	
2605	63		1	150	80	1		1		1			1	
3320	64		1	166	88	1			1	1			1	
2717	65		1	150	80	1		1			1			1
1128	66		1	135	80	1		1			1		1	
1782	66		1	155	88	1		1		1			1	
2427	66		1	140	90	1		1			1		1	
503	66		1	140	100	1		1				1		1
135	67		1	162	82		1		1		1		1	
2605	63		1	150	80	1		1		1			1	
2972	64		1	160	90	1			1		1			1
3083	65		1	140	80	1		1				1	1	
2560	66		1	145	82	1		1			1		1	
3159	68		1	160	90	1			1	1			1	
443	69		1	150	85	1		1			1		1	
			16			15	1	10	6	5	8	3	12	4

759	62	1		160	84		1		1		1			1
6	65	1		160	90	1			1	1				1
515	65	1		155	90		1	1			1		1	
220	66	1		140	75	1		1			1		1	
503	67	1		154	90	1		1		1			1	
703	68	1		145	80	1		1		1				1
1918	60	1		145	90	1		1			1		1	
3231	61	1		132	80	1		1				1	1	
1261	63	1		140	70	1		1			1		1	
3349	64	1		166	104	1			1		1		1	
2280	64	1		130	90	1		1			1		1	
1897	66	1		158	84	1		1			1		1	
2356	67	1		150	90	1		1		1				1
2085	68	1		155	85	1		1		1			1	
1782	68	1		140	90	1		1		1			1	
		15				13	2	12	3	6	8	1	11	4
2238	70	1		160	86		1		1	1			1	
363	71	1		140	80	1		1			1		1	
406	71	1		160	90	1			1	1			1	
581	72	1		190	100		1		1			1		1
1364	72	1		140	85	1		1		1			1	
2158	72	1		180	76	1			1	1			1	
1843	72	1		178	88	1			1	1			1	
2204	74	1		180	90	1			1		1		1	
1077	74	1		128	80	1		1			1		1	
664	75	1		150	86	1		1		1			1	
1494	76	1		160	90		1		1		1		1	
2961	73	1		128	80	1		1		1			1	
		12				9	3	5	7	7	4	1	11	1
2993	72		1	150	80	1		1			1		1	
2238	70		1	164	98	1			1	1			1	
1410	72		1	140	70	1		1			1		1	
1654	73		1	180	80	1			1	1			1	
599	75		1	160	90	1			1		1		1	
641	75		1	160	90	1			1		1		1	
1059	77		1	170	70	1			1		1		1	
2043	77		1	138	74	1		1		1			1	
1490	78		1	170	80	1			1		1			1
906	79		1	160	90		1		1		1		1	
			10			9	1	3	7	3	7		9	1
677	80		1	120	90		1	1		1			1	
574	81		1	160	80	1			1	1			1	
327	86		1	150	80	1		1		1				1
3384	87		1	140	80	1		1		1			1	
979	88		1	140	95	1		1			1		1	
			5			4	1	4	1	4	1		4	1
2256	94		1	190	80		1		1		1		1	

AGE		SEX				TREAT		CONTROL		TOD			COMPLIANCE	
		M	F			+	-	+	-	+	-	?	+	-
30-39		4				2	2	3	1		4		3	1
			1			1		1				1		1
40-49		7				4	3	5	2		3	4	5	2
			8			2	6	5	3		3	5	6	2
50-59		10				9	1	4	6	6	3	1	8	2
			11			11		10	1		6	5	8	3
60-69		15				13	2	12	3	6	8	1	11	4
			16			15	1	10	6	5	8	3	12	4
70-79		12				9	3	5	7	7	4	1	11	1
			10			9	1	3	7	3	7		9	1
80-89			5			4	1	4	1	4	1		4	1
90-94			1				1		1		1		1	
	Total	48	52			79	21	62	38	31	48	21	78	22

D.O.B. ____/____/________ (d / m / yr) Name: ________________________ Sex: M ☐ ; F ☐

HYPERTENSION FLOW CHART

Ht: ________ cm. Wt: ________ kg.

Risk

\+ ***Risk Factors:***

- O O Male
- O O Black race
- O O Elevated BP; Previous HTN Meds.
- O O Smokes
- O O Drinks (> 2 oz / day)
- O O High Cholesterol
- O O Glucose Intolerance
- O O Oral Contraceptives; Conj. Estrogens
- O O Corticosteroids; NSAIDS
- O O Thyroid hormone; Licorice
- O O Amphetamines

Family History:

- O O HTN; CAD; CVD
- O O Stroke
- O O Diabetes Mellitus
- O O Polycystic Kidney

Secondary HTN:

- O O Cushingoid appearance
- O O Coarctn. Aorta femoral delay
- O O Renovascular - Abdom. bruit
- O O Renal mass
- O O Pheo.-cytoma - (headache; paroxysml. BP; pallor; palpitatns; perspiratn.)
- O O Conn's - Serum K

Target Organ Damage:

- O O History of Angina/MI
- O O History of TIA/Stroke
- O O History of PVD
- O O History of Renal Insufficiency
- O O LVH on ECG
- O O Creatinine >150
- O O Aneurysm: thoracic/abdom.(elderly)

Investigations:

- O O Urinalysis
- O O CBC
- O O Glucose
- O O Elevated Serum creatinine
- O O Low serum K
- O O Calcium
- O O ? Gout
- O O HDL-C; Total Cholesterol
- O O TSH
- O O LVH/MI/ Ischaemia on ECG
- O O Micro-albuminuria
- O O LVH on Echocardiogram

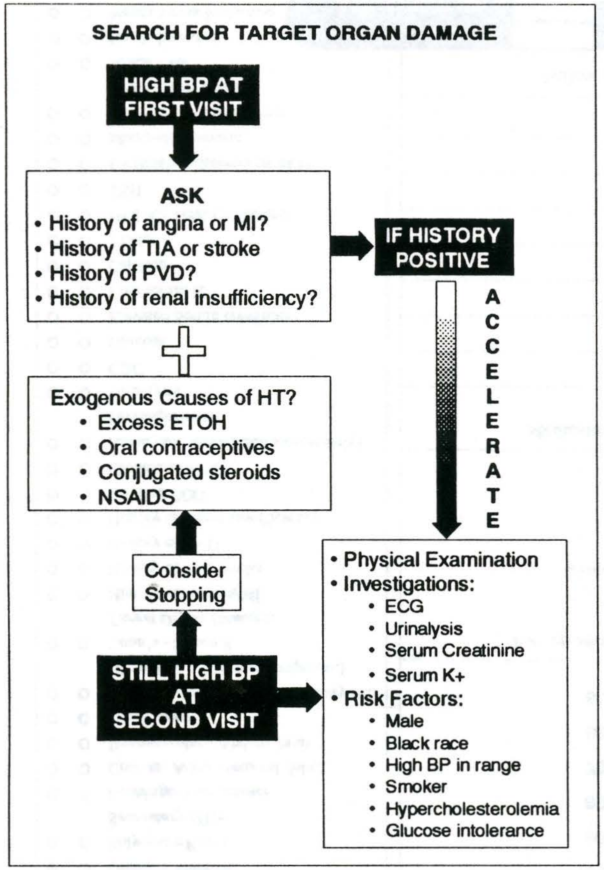
Behavioural Issues:

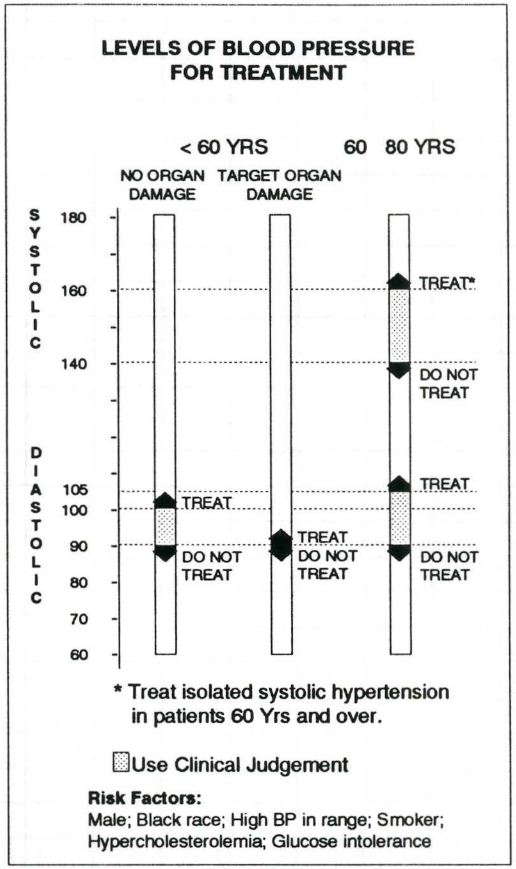
- O O Needs Diet
- O O Needs Exercise
- O O Needs Stress Reduction
- O O Poor Compliance

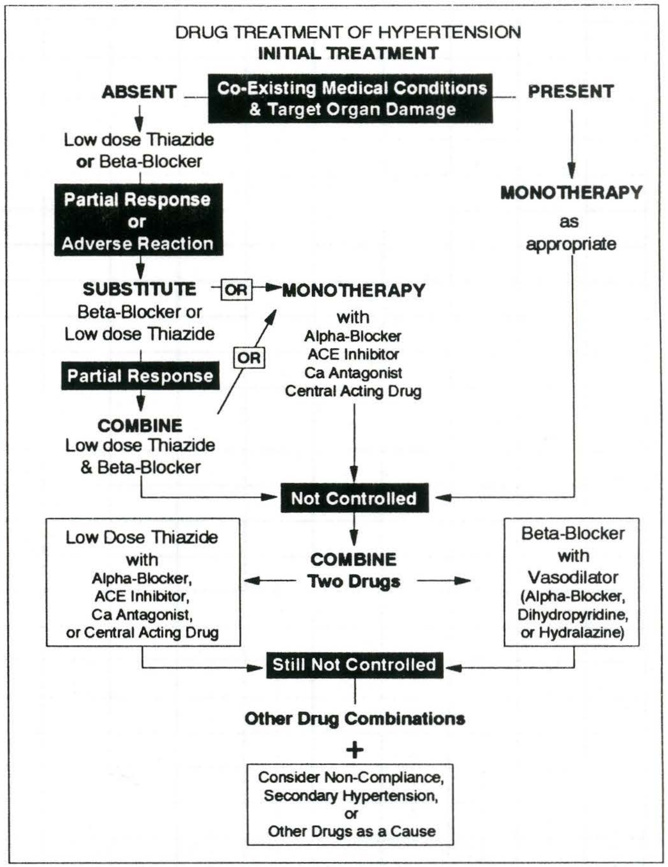
Date																		
BP: 210																		
200																		
190																		
180																		
170																		
160																		
150																		
140																		
130																		
120																		
110																		
100																		
90																		
80																		
70																		
60																		
50																		
Bld. creatinine																		
K+																		
Glucose																		
Medications:																		
Follow-up:																		

Pt's 10-yr.Risk of CAD = ______ %

Average 10-yr risk = ______ %







DRUG TREATMENT OF HYPERTENSION WITH CO-EXISTING CONDITIONS

CONDITION	RECOMMENDED	ALTERNATIVE DRUGS	NOT RECOMMENDED
ISCHEMIC HEART DISEASE • Angina	Beta-Blockers	Ca Antag; (dihydropyridines + Beta-Blockers) Ca, Antag. (if LV function not severely impaired)	dihydropyridines
• Recent MI	Beta Blockers		
CHF	diuretics; ACE Inhib.	hydralazine + isosorbide dinitrate	Beta-Blockers; Ca. Antag.
PVD	vasodilators	Beta-Blockers may be used	Beta-Blockers
DYSLIPIDEMIA	Alpha-Blockers; ACE Inhib.; Beta-Blockers with ISA; Ca Antag.; Central acting Drugs	low dose thiazide	High dose thiazides; Beta-Blockers without ISA
DIABETES MELLITUS	Alpha-Blockers; ACE Inhib.; Ca Antag.	Beta-Blockers, thiazides, and central acting drugs, or vasodilators if others contraindicated.	High dose thiazides; Beta-Blockers without ISA
ASTHMA	(K - sparing + thiazide)		Beta-Blockers
GOUT			Thiazides
PREGNANCY	methyldopa; clonidine; hydralazine; Beta-Blockers		ACE Inhib.; Ca. Antag.
BLACK PATIENTS	Low dose thiazide; Ca Antag	Beta-Blockers; ACE Inhibitors (less effective)	

GUIDE TO COMMON HYPERTENSIVE DRUGS

DRUG	DAILY DOSE (mg) START	FULL
THIAZIDES:		
chlorthalidone (Hygroton)	12.5	25
hydrochlorthiazide (HydroDiuril)	12.5	50
indapamide (Lozide)	2.5	2.5
metazolone (Zaroxolyn)	2.5	5
BETA-BLOCKERS:		
acebutolol (Monitan, Sectral) [ISA]	200	800
atenolol (Tenormin)	25	100
labetalol (Trandate)	200	1200
metoprolol (Lopresor, Betaloc)	50	200
nadolol (Corgard)	20	160
oxprenolol (Trasicor) [ISA]	80	320
pindolol (Visken) [ISA]	10	30
propranolol (Inderal)	80	320
timolol (Blocadren)	10	40
ACE INHIBITORS:		
captopril (Capoten)	25	100
enalapril (Vasotec)	5	20
fosinopril (Monopril)	10	40
lisinopril (Prinivil, Zestril)	5	20
quinapril (Accupril)	10	40
CALCIUM ANTAGONISTS:		
amlodipine (Norvasc) [D][V]	5	10
diltiazem (Cardizem)	120	360
felodipine (Plendil, Renedil) [D][V]	5	20
nicardipine (Cardene) [D][V]	60	120
nifedipine (Adalat) [D][V]	20	80
verapamil (Isoptin)	120	480

DRUG	DAILY DOSE (mg) START	FULL
CENTRALLY ACTING DRUGS:		
clonidine (Catapres)	0.2	1.2
methyldopa (Aldomet)	500	2000
reserpine (Serpasil)	0.1	0.25
ALPHA BLOCKERS:		
doxazosin (Cardura)	1	8
prazosin (Minipress)	0.5	20
terazosin (Hytrin)	1	10
VASODILATORS:		
hydralazine (Apresoline) [V]	50	200
minoxidil (Loniten) [V]	5	20
COMBO with HCTZ:		
Aldactazide (spironolactone+hctz)	1/2 tab	1 tab
Dyazide (triamterine+hctz)	1/2 tab	1 tab
Moduret (amiloride+hctz)	1/2 tab	1 tab
Tenoretic (atenolol+hctz)	1/2 tab	2 tab
Tomolide (timolol+hctz)	1/2 tab	2 tab
Vaseretic (enalapril+hctz)	1/2 tab	2 tab

KEY:

[D] Dihydropyridine

[ISA] Intrinsic Sypathomimetic activity

[V] Vasodilator

[Adapted from Evans CE: *The Canadian Consensus on Hypertension ManAgement 1984-1992* Canadian Hypertension Society 1993]

Coronary Artery Disease Risk Prediction Chart

1. Find Points For Each Risk Factor

Age: Female				Age: Male				HDL-Cholesterol		Total-Cholesterol		Systolic BP		Other Factors	
age	pts.	age	pts.	age	pts.	age	pts.	HDL-C mmol/L	pts.	total-C mmol/L	pts.	SBP	pts.		pts.
30	-12	41	1	30	-2	48-49	9	.65-.69	7	3.59-3.92	-3	98-104	-2	Cigarettes	4
31	-11	42-43	2	31	-1	50-51	10	.70-.77	6	3.93-4.31	-2	105-112	-1	Diabetic - male	3
32	-9	44	3	32-33	0	52-54	11	.78-.84	5	4.32-4.72	-1	113-120	0	Diabetic - female	6
33	-8	45-46	4	34	1	55-56	12	.85-.92	4	4.73-5.16	0	121-129	1	ECG - LVH	9
34	-6	47-48	5	35-36	2	57-59	13	.93-1.00	3	5.17-5.68	1	130-139	2		
35	-5	49-50	6	37-38	3	60-61	14	1.01-1.10	2	5.69-6.20	2	140-149	3	[0 pts for each NO]	
36	-4	51-52	7	39	4	62-64	15	1.11-1.21	1	6.21-6.79	3	150-160	4		
37	-3	53-55	8	40-41	5	65-67	16	1.22-1.31	0	6.80-7.46	4	161-172	5		
38	-2	56-60	9	42-43	6	68-70	17	1.32-1.44	-1	7.47-8.16	5	173-185	6		
39	-1	61-67	10	44-45	7	71-73	18	1.45-1.57	-2	8.17-8.53	6				
40	0	68-74	11	46-47	8	74	19	1.58-1.72	-3						
								1.73-1.90	-4						
								1.91-2.08	-5						
								2.09-2.27	-6						
								2.28-2.48	-7						

Note: Conversion from standard to SI units
mg / dl x 0.02586 = mmol / L

2. Sum Points For All Risk Factors:

NOTE: *Minus Points Subtract From Total*

______ + ______ + ______ + ______ + ______ + ______ = ______
AGE HDL-C TOTAL-C SBP DIABETES ECG-LVH POINT TOTAL

3. Look Up Risk Corresponding To Point Total: / 4. Compare To Average 10 Year Risk

pts.	Probability % 5 yr.	Probability % 10 yr.	pts.	Probability % 5 yr.	Probability % 10 yr	pts.	Probability % 5 yr.	Probability % 10 yr.	pts.	Probability % 5 yr.	Probability % 10 yr.	age	Probability % female	Probability % male
1	1	2	10	2	6	19	8	16	28	19	33	30-34	<1	3
2	1	2	11	3	6	20	8	18	29	20	36	35-39	<1	5
3	1	2	12	3	7	21	9	19	30	22	38	40-44	2	6
4	1	2	13	3	8	22	11	21	31	24	40	45-49	5	10
5	1	3	14	4	9	23	12	23	32	25	42	50-54	8	14
6	1	3	15	5	10	24	13	25				55-59	12	16
7	1	4	16	5	12	25	14	27				60-64	13	21
8	2	4	17	6	13	26	16	29				65-69	9	30
9	2	5	18	7	14	27	17	31				70-74	12	24

Adapted from : Kannel WB, D'Agostino R, Anderson K, and McGee D: Framingham Heart Study, American Heart Association 1990.

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