表3－1　女性参加者登録時データ　肥満者割合高度地区（岩泉・普代・種市・田老・山形）

年齢階級	18-29	30-39	40-49	50-59	60-69	70-79	≥80	合計
参加人数	63	190	398	826	1,297	806	75	3,655
BMI	21.6 (3.9)	22.7 (3.9)	23.9 (4.1) *	24.4 (3.4) †*	24.9 (3.4) †*	24.6 (3.5) †*	24.9 (4.6)	24.4 (3.6)
BMI≥25	14.3%	22.6%	31.9%	39.0%	46.0%	43.9%	37.8%	40.5%
BMI≥30	6.3%	5.8%	8.3% *	6.3%	7.9% †*	7.5%	4.1%	7.3%
SBP	102.3 (11.8)	108.2 (14.0)	115.1 (16.4)	123.6 (19.7) †*	130.0 (20.1) †*	132.2 (19.3)	137.9 (21.7)	125.9 (20.6)
TC	164.2 (25.8)	172.3 (27.4)	189.9 (32.4)	203.3 (31.9)	204.7 (31.4)	200.0 (29.0)	197.0 (31.6)	199.2 (32.1)
中性脂肪	68.5 (45.8)	84.1 (57.2)	90.6 (115.8)	102.2 (59.0)	105.4 (55.5)	107.9 (54.8)	102.9 (42.9)	101.8 (65.6)
HDLC	63.9 (14.7)	63.7 (14.1)	64.3 (14.1)	63.3 (13.6)	60.5 (13.9)	59.9 (14.4)	57.2 (11.9)	61.6 (14.1)
LDLC	90.7 (25.0)	96.3 (24.6)	110.0 (28.5)	120.2 (29.4)	123.2 (28.0)	118.8 (25.4)	118.4 (26.9)	118.1 (28.5)
血糖	92.6 (13.1)	95.2 (13.9)	99.0 (17.0)	105.0 (25.5)	109.7 (27.8)	115.3 (29.7)	132.8 (49.7)	108.1 (27.5)
HbA_{1C}	4.65 (0.29)	4.80 (0.28)	4.92 (0.46)	5.12 (0.64) †	5.24 (0.69) †*	5.29 (0.62) †*	5.39 (0.92)	5.16 (0.64)
喫煙者	19.0%	16.8%	5.3%	2.5%	1.0%	1.4%	0.0%	3.0%
常用飲酒	7.9%	12.6%	6.8%	3.4%	2.2%	1.9%	2.7%	3.5%
運動習慣	9.5%	6.8%	8.5%	8.8% *	7.7% *	8.2% *	9.3%	8.2%
糖尿病	0.0%	0.0%	1.3%	3.5%	5.2%	7.2% *	10.7%	4.6%
高血圧	1.6%	4.2%	12.6%	33.2% †*	48.3%	64.6% †*	65.3%	41.9%
高脂血症	4.8%	5.8%	17.6%	33.3%	37.1%	34.5%	28.0%	31.2%

データは平均値（標準偏差）または割合（%）で示す。†は肥満地区と九戸郡地区で有意差（$p<0.05$）があることを示す。*は肥満地区と宮古市で有意差（$p<0.05$）があることを示す。連続変数の検定は一元配置分散分析で行い、多重比較にはボンフェローニの修正式を用いた。割合の比較にはχ二乗検定を用いた。

表3－2　女性参加者登録時データ　宮古市地区

年齢階級	18-29	30-39	40-49	50-59	60-69	70-79	≥80	合計
参加人数	73	209	227	570	911	465	48	2,503
BMI	21.6 (4.5)	21.8 (3.3)	22.9 (3.5)	23.2 (3.1)	23.7 (3.1)	23.8 (3.3)	23.4 (3.2)	23.3 (3.3)
BMI≥25	12.3%	18.2%	24.2%	25.8%	31.2%	34.0%	33.3%	28.2%
BMI≥30	6.8%	2.9%	3.1%	3.0%	3.0%	4.5%	6.3%	3.4%
SBP	100.5 (10.4)	104.7 (13.2)	113.1 (15.6)	117.9 (18.3)	125.2 (18.6)	130.4 (19.8)	134.8 (22.8)	121.2 (19.8)
TC	167.7 (29.7)	174.5 (27.7)	189.7 (30.5)	210.2 (30.7)	211.8 (29.9)	208.1 (29.7)	203.3 (31.6)	204.2 (32.5)
中性脂肪	77.2 (86.0)	86.7 (66.3)	88.6 (62.0)	95.4 (50.5)	102.2 (50.2)	105.2 (51.7)	105.7 (44.9)	98.0 (54.8)
HDLC	61.4 (14.3)	61.2 (13.1)	62.5 (13.4)	62.4 (14.0)	60.3 (14.6)	59.2 (14.6)	60.4 (14.5)	60.9 (14.3)
LDLC	96.1 (27.8)	101.0 (24.5)	113.8 (28.3)	130.3 (27.9)	132.4 (27.6)	128.7 (25.8)	122.5 (25.2)	125.7 (29.1)
血糖	88.1 (10.2)	91.0 (9.3)	95.3 (22.1)	100.1 (20.9)	101.6 (19.1)	101.5 (19.1)	101.5 (15.7)	99.4 (19.3)
HbA_{1C}	4.69 (0.26)	4.72 (0.31)	4.84 (0.46)	5.08 (0.59)	5.16 (0.53)	5.15 (0.46)	5.13 (0.55)	5.06 (0.53)
喫煙者	20.5%	14.4%	9.3%	3.7%	1.2%	0.4%	0.0%	4.0%
常用飲酒	6.8%	13.4%	11.9%	4.9%	5.5%	2.2%	10.4%	6.1%
運動習慣	13.7%	8.1%	9.3%	16.3%	18.2%	13.8%	8.3%	15.0%
糖尿病	0.0%	0.0%	1.3%	2.3%	3.2%	3.2%	4.2%	2.5%
高血圧	0.0%	4.8%	11.0%	24.2%	36.2%	52.5%	52.1%	30.8%
高脂血症	8.2%	11.5%	17.2%	41.9%	49.2%	47.7%	29.2%	39.6%

データは平均値（標準偏差）または割合（%）で示す。

表3－3　女性参加者登録時データ　肥満者割合が低い町村地区（九戸郡：軽米・九戸・大野）

年齢階級	18-29	30-39	40-49	50-59	60-69	70-79	≥80	合計
参加人数	40	138	308	514	798	497	58	2,353
BMI	21.8 (4.7)	22.7 (3.9)	23.4 (3.3)	23.9 (3.5)	24.1 (3.3)	24.1 (3.5)	23.9 (3.0)	23.8 (3.4)
BMI≥25	17.5%	24.6%	28.2%	34.9%	36.1%	36.9%	33.9%	33.9%
BMI≥30	7.5%	5.8%	4.2%	6.2%	4.6%	4.9%	3.6%	5.1%
SBP	104.6 (10.9)	110.0 (15.9)	114.6 (17.0)	120.2 (18.5)	127.3 (19.6)	131.1 (19.9)	136.7 (22.0)	123.7 (20.1)
TC	172.4 (31.5)	180.2 (31.6)	189.4 (31.9)	204.2 (31.6)	203.5 (28.7)	202.8 (29.2)	189.7 (25.6)	199.4 (31.0)
中性脂肪	86.0 (69.5)	99.7 (65.6)	109.2 (69.8)	123.2 (77.6)	130.0 (68.6)	135.5 (80.5)	123.9 (64.1)	124.3 (74.0)
HDLC	62.9 (15.2)	64.2 (14.5)	61.7 (14.5)	61.8 (14.7)	60.4 (13.9)	57.4 (14.2)	57.4 (12.1)	60.4 (14.4)
LDLC	99.5 (27.1)	104.0 (29.3)	112.2 (28.5)	122.7 (28.5)	122.1 (25.3)	123.5 (26.3)	111.6 (18.4)	119.5 (27.5)
血糖	93.7 (11.8)	97.7 (19.9)	103.8 (29.8)	107.5 (21.3)	112.7 (30.3)	115.6 (28.1)	120.6 (30.9)	110.0 (27.8)
HbA_{1C}	4.59 (0.28)	4.73 (0.64)	4.87 (0.56)	5.03 (0.54)	5.12 (0.59)	5.17 (0.62)	5.26 (0.62)	5.05 (0.60)
喫煙者	30.0%	15.2%	7.5%	2.5%	0.5%	0.4%	0.0%	3.2%
常用飲酒	10.0%	10.9%	10.4%	5.8%	3.6%	3.0%	3.4%	5.4%
運動習慣	7.5%	5.8%	4.5%	8.8%	9.6%	8.9%	15.5%	8.5%
糖尿病	0.0%	0.7%	1.3%	2.1%	4.0%	4.2%	12.1%	3.2%
高血圧	0.0%	5.1%	11.0%	23.3%	41.4%	54.5%	69.0%	34.1%
高脂血症	15.0%	9.4%	17.9%	35.6%	38.1%	40.0%	24.1%	32.9%

データは平均値（標準偏差）または割合（%）で示す。

3町村地域は肥満者集積地域と宮古市との中間の値であった。

表4は栄養調査の結果得られた男性住民の1日あたりの栄養素摂取量平均値を年齢階級別に示したものである。肥満者集積地域と宮古市で栄養摂取量では明らかな違いは見出せなかった。40代から70代の世代を比較すると，肥満者集積地域では，摂取カロリーに占める炭水化物摂取量が宮古市に比較し高く，脂肪の摂取量が低い傾向にあった。飽和脂肪酸摂取量に限ってもむしろ北部沿岸町村で高い傾向にあった。旧九戸郡内陸3町村地区住民の栄養調査結果は，肥満者集積地域と同様に炭水化物摂取量が多く，脂肪摂取量が少ない傾向にあり，この調査結果は都市型住民と山間地域住民の差を示していることが推測された。

表5は女性住民の栄養調査結果を年齢階級別に示したものである。男性と同様に肥満者集積地域では宮古市住民と比較してたんぱく質と脂肪摂取量が少なく，炭水化物摂取量が多い傾向にあった。旧九戸郡内陸3町村地区住民の栄養摂取内容は肥満者集積地域と同様の結果が得られた。

図2は年齢階級別に高度肥満者割合を棒グラフで示したものである。男性では50歳以上で肥満者集積地域の高度肥満者割合が高いことがわかる。一方女性では，30歳以上の全ての世代で肥満者集積地域の高度肥満者割合が宮古市のほぼ2倍となっており，肥満の地域差に関しては，女性でより顕著な差が見られることがわかる。

表4－1　男性参加者登録時データ　肥満者割合高度地区（岩泉・普代・種市・田老・山形）：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
参加人数	43	129	235	495	223	1,173
総カロリー kcal/day	2391 ± 844	2551 ± 848	2589 ± 810	2490 ± 802	2334 ± 732	2479 ± 798
炭水化物 g/day (%)	322.2 (53.9%)	357.8 (56.5%)	363.8 (56.4%)	341.3 (55.3%)	326.4 (55.8%)	343.4 (55.7%)
タンパク質 g/day (%)	81.8 (13.8%)	82.2 (13.0%)	92.2 (14.3%)	96.2 (15.4%)	95.0 (16.3%)	93.1 (15.0%)
脂肪 g/day (%)	57.9 (22.0%)	54.9 (19.5%)	60.1 (20.7%)	62.3 (22.3%)	60.9 (23.4%)	60.8 (22.0%)
飽和脂肪	15.2 (5.7%)	13.6 (4.9%)	15.1 (5.2%)	15.3 (5.5%)	15.1 (5.8%)	15.1 (5.5%)
1価不飽和	20.2 (7.6%)	18.8 (6.6%)	20.2 (6.9%)	20.8 (7.4%)	20.2 (7.7%)	20.4 (7.4%)
多価値不飽和	14.8 (5.7%)	15.0 (5.3%)	16.3 (5.6%)	17.0 (6.1%)	16.8 (6.5%)	16.6 (6.0%)
n-6PUFA	11.5 (4.4%)	11.7 (4.2%)	12.2 (4.2%)	12.3 (4.4%)	12.1 (4.7%)	12.2 (4.4%)
n-3PUFA	3.3 (1.3%)	3.3 (1.2%)	3.9 (1.3%)	4.3 (1.5%)	4.2 (1.6%)	4.1 (1.5%)
αリノレイン酸	1.9 (0.7%)	2.0 (0.7%)	2.1 (0.7%)	2.1 (0.8%)	2.1 (0.8%)	2.1 (0.8%)
EPA+DHA	1.4 (0.5%)	1.4 (0.5%)	1.9 (0.6%)	2.2 (0.8%)	2.1 (0.8%)	2.0 (0.7%)
n6/n3 ratio	3.7 ± 1.0	3.7 ± 0.9	3.2 ± 0.9	3.1 ± 0.9	3.0 ± 1.0	3.2 ± 1.0
コレステロール (mg/day)	356 ± 164	351 ± 171	405 ± 210	419 ± 221	431 ± 227	410 ± 215
食塩 (g/day)	13.3 ± 4.2	14.4 ± 4.7	15.8 ± 5.4	16.7 ± 5.7	16.8 ± 5.6	16.1 ± 5.6

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

表4－2　男性参加者登録時データ　宮古市地区：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
参加人数	39	42	139	350	255	863
総カロリー kcal/day	2294 ± 803	2589 ± 898	2646 ± 927	2287 ± 701	2359 ± 676	2358 ± 782
炭水化物 g/day (%)	327.2 (56.9%)	358.7 (55.8%)	354.1 (53.8%)	306.6 (53.9%)	300.8 (53.7%)	316.7 (54.1%)
タンパク質 g/day (%)	76.6 (13.7%)	94.3 (14.4%)	96.4 (14.5%)	91.5 (16.1%)	95.9 (16.9%)	93.2 (15.9%)
脂肪 g/day (%)	57.5 (23.1%)	62.9 (21.7%)	63.2 (21.5%)	61.0 (23.8%)	64.3 (25.3%)	62.7 (23.8%)
飽和脂肪	15.8 (6.3%)	16.5 (5.7%)	16.5 (5.7%)	15.4 (6.1%)	16.3 (6.4%)	16.1 (6.1%)
1価不飽和	19.7 (7.9%)	21.4 (7.4%)	21.2 (7.2%)	20.4 (7.9%)	21.4 (8.4%)	21.0 (7.9%)
多価値不飽和	14.5 (5.9%)	16.3 (5.6%)	16.5 (5.6%)	16.3 (6.4%)	17.2 (6.7%)	16.6 (6.3%)
n-6PUFA	11.9 (4.8%)	12.8 (4.4%)	12.1 (4.1%)	11.9 (4.6%)	12.4 (4.9%)	12.2 (4.6%)
n-3PUFA	3.0 (1.2%)	3.6 (1.2%)	4.0 (1.3%)	4.0 (1.6%)	4.3 (1.7%)	4.0 (1.5%)
αリノレイン酸	1.9 (0.8%)	2.0 (0.7%)	2.0 (0.7%)	2.1 (0.8%)	2.1 (0.8%)	2.1 (0.8%)
EPA+DHA	1.1 (0.4%)	1.6 (0.5%)	2.0 (0.6%)	2.0 (0.8%)	2.1 (0.8%)	2.0 (0.7%)
n6/n3 ratio	4.0 ± 0.7	3.7 ± 0.9	3.3 ± 1.0	3.2 ± 1.0	3.1 ± 0.9	3.2 ± 1.0
コレステロール (mg/day)	333 ± 145	418 ± 237	421 ± 238	400 ± 199	435 ± 213	413 ± 214
食塩 (g/day)	12.7 ± 4.1	16.2 ± 6.5	16.5 ± 6.9	16.2 ± 5.4	16.8 ± 5.0	16.3 ± 5.7

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

表4－3 男性参加者登録時データ 肥満者割合が低い町村地区（九戸郡：軽米・九戸・大野）：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
参加人数	74	179	268	397	54	1,017
総カロリー kcal/day	2598 ± 836	2689 ± 815	2722 ± 831	2644 ± 770	2663 ± 963	2666 ± 815
炭水化物 g/day (%)	373.2 (57.7%)	382.7 (56.8%)	381.7 (56.0%)	371.9 (56.5%)	366.4 (54.9%)	375.8 (56.5%)
タンパク質 g/day (%)	85.2 (13.1%)	86.8 (13.0%)	96.7 (14.2%)	100.3 (15.2%)	105.4 (16.0%)	95.5 (14.4%)
脂肪 g/day (%)	60.6 (20.9%)	60.1 (20.3%)	66.1 (21.8%)	67.1 (22.8%)	72.6 (24.7%)	65.3 (22.1%)
飽和脂肪	15.6 (5.4%)	14.7 (4.9%)	16.5 (5.5%)	16.8 (5.7%)	17.5 (5.9%)	16.3 (5.5%)
1価不飽和	21.0 (7.3%)	20.7 (7.0%)	22.5 (7.4%)	22.6 (7.6%)	24.8 (8.4%)	22.2 (7.5%)
多価値不飽和	16.2 (5.5%)	16.7 (5.6%)	18.0 (5.9%)	18.3 (6.2%)	20.1 (6.9%)	17.9 (6.0%)
n-6PUFA	13.2 (4.5%)	13.4 (4.5%)	14.0 (4.6%)	14.0 (4.7%)	15.0 (5.2%)	13.9 (4.7%)
n-3PUFA	3.4 (1.2%)	3.6 (1.2%)	4.2 (1.4%)	4.3 (1.4%)	4.7 (1.6%)	4.1 (1.4%)
αリノレイン酸	2.2 (0.7%)	2.2 (0.8%)	2.4 (0.8%)	2.4 (0.8%)	2.6 (0.9%)	2.3 (0.8%)
EPA+DHA	1.2 (0.4%)	1.4 (0.5%)	1.8 (0.6%)	1.9 (0.6%)	2.2 (0.7%)	1.7 (0.6%)
n6/n3 ratio	4.0 ± 0.7	3.8 ± 0.8	3.6 ± 0.90	3.4 ± 0.90	3.4 ± 1.0	3.6 ± 0.9
コレステロール (mg/day	371 ± 162	385 ± 177	441 ± 213	441 ± 208	489 ± 269	425 ± 206
食塩 (g/day)	13.9 ± 5.5	14.4 ± 4.6	15.8 ± 5.3	16.7± 4.6	17.3 ± 5.9	15.7 ± 5.2

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

表5－1 女性参加者登録時データ 肥満者割合高度地区（岩泉・普代・種市・田老・山形）：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
肥満者割合高度地区						
参加人数	173	353	668	895	280	2,436
総カロリー kcal/day	1688 ± 458	1754 ± 441	1796 ± 524	1876 ± 660	1794 ± 606	1806 ± 575
炭水化物 g/day (%)	237.4 (56.4%)	248.3 (57.0%)	257.1 (57.9%)	268.6 (58.1%)	254.8 (57.7%)	257.3 (57.6%)
タンパク質 g/day (%)	62.7 (14.8%)	67.0 (15.2%)	71.2 (15.7%)	77.5 (16.3%)	74.6 (16.4%)	72.4 (15.9%)
脂肪 g/day (%)	48.7 (25.8%)	51.4 (26.0%)	52.0 (25.5%)	54.1 (25.3%)	52.4 (25.6%)	52.4 (25.6%)
飽和脂肪	13.2 (7.0%)	13.6 (6.9%)	13.4 (6.6%)	13.8 (6.5%)	13.3 (6.5%)	13.5 (6.6%)
1価不飽和	16.6 (8.8%)	17.5 (8.9%)	17.5 (8.5%)	17.9 (8.3%)	17.4 (8.5%)	17.6 (8.5%)
多価値不飽和	12.3 (6.6%)	13.3 (6.7%)	13.7 (6.7%)	14.6 (6.8%)	14.2 (7.0%)	13.9 (6.8%)
n-6PUFA	9.9 (5.3%)	10.3 (5.2%)	10.3 (5.1%)	10.7 (5.0%)	10.5 (5.1%)	10.4 (5.1%)
n-3PUFA	2.7 (1.4%)	3.0 (1.5%)	3.2 (1.6%)	3.6 (1.7%)	3.5 (1.7%)	3.3 (1.6%)
αリノレイン酸	1.6 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)
EPA+DHA	1.0 (0.5%)	1.3 (0.6%)	1.4 (0.7%)	1.8 (0.8%)	1.7 (0.8%)	1.5 (0.7%)
n6/n3 ratio	3.9 ± 0.8	3.6 ± 0.9	3.4 ± 0.90	3.2 ± 1.0	3.2 ± 1.0	3.4 ± 1.0
コレステロール (mg/day)	297 ± 125	311 ± 137	320 ± 163	349 ± 199	341 ± 195	3303 ± 176
食塩 (g/day)	10.4 ± 3.0	11.3 ± 3.4	12.4 ± 4.1	13.9± 5.0	13.4 ± 4.6	12.7 ± 4.5

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

表5－2 女性参加者登録時データ 宮古市地区：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
参加人数	176	204	475	740	337	2,021
総カロリー kcal/day	1792 ± 514	1879 ± 532	1757 ± 494	1807 ± 552	1784 ± 564	1794 ± 536
炭水化物 g/day (%)	247.8 (54.9%)	255.4 (54.4%)	248.2 (56.9%)	251.3 (56.2%)	250.9 (56.8%)	250.5 (56.2%)
タンパク質 g/day (%)	65.1 (14.6%)	71.3 (15.2%)	70.3 (15.9%)	76.9 (17.0%)	75.1 (16.8%)	73.1 (16.3%)
脂肪 g/day (%)	54.5 (27.5%)	59.0 (28.3%)	51.9 (26.3%)	53.9 (26.6%)	53.9 (26.7%)	54.0 (26.8%)
飽和脂肪	15.6 (7.9%)	16.5 (8.0%)	14.1 (7.1%)	14.2 (7.0%)	14.2 (7.0%)	14.6 (7.3%)
1価不飽和	18.5 (9.3%)	20.2 (9.7%)	17.3 (8.7%)	17.9 (8.8%)	17.9 (8.8%)	18.1 (8.9%)
多価値不飽和	13.3 (6.7%)	14.5 (6.9%)	13.2 (6.7%)	13.9 (6.9%)	14.0 (7.0%)	13.7 (6.8%)
n-6PUFA	10.8 (5.5%)	11.4 (5.5%)	9.8 (5.0%)	10.1 (5.0%)	10.3 (5.1%)	10.3 (5.1%)
n-3PUFA	2.7 (1.4%)	3.1 (1.5%)	3.1 (1.5%)	3.4 (1.7%)	3.4 (1.7%)	3.2 (1.6%)
αリノレイン酸	1.8 (0.9%)	1.9 (0.9%)	1.7 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)
EPA+DHA	0.9 (0.5%)	1.2 (0.6%)	1.4 (0.7%)	1.6 (0.8%)	1.6 (0.8%)	1.4 (0.7%)
n6/n3 ratio	4.1 ± 0.8	3.8 ± 0.9	3.4 ± 0.9	3.2 ± 0.9	3.2 ± 0.9	3.4 ± 1.0
コレステロール (mg/day)	312 ± 119	342 ± 135	314 ± 153	347 ± 166	346 ± 162	335 ± 155
食塩 (g/day)	11.1 ± 3.5	12.0 ± 3.8	12.5 ± 4.0	13.7± 4.2	13.7 ± 4.4	12.9 ± 4.2

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

表5－3　女性参加者登録時データ　肥満者割合が低い町村地区（九戸郡：軽米・九戸・大野）：栄養調査

年齢階級	30-39	40-49	50-59	60-69	70-79	合計
参加人数	135	297	491	728	95	1,793
総カロリー kcal/day	1791 ± 545	1801 ± 539	1895 ± 580	1908 ± 527	1894 ± 594	1871 ± 579
炭水化物 g/day (%)	253.4 (56.8%)	256.8 (57.4%)	272.1 (57.8%)	274.6 (57.9%)	270.0 (57.5%)	268.3 (57.7%)
タンパク質 g/day (%)	65.5 (14.6%)	66.6 (14.7%)	73.6 (15.4%)	76.1 (15.9%)	75.1 (15.9%)	72.5 (15.4%)
脂肪 g/day (%)	52.0 (26.0%)	52.4 (25.9%)	54.9 (25.7%)	54.6 (25.4%)	55.4 (25.8%)	54.0 (25.7%)
飽和脂肪	14.3 (7.1%)	13.9 (6.9%)	14.2 (6.7%)	14.1 (6.6%)	14.2 (6.6%)	14.1 (6.7%)
1価不飽和	17.7 (8.8%)	17.8 (8.8%)	18.5 (8.6%)	18.2 (8.4%)	18.7 (8.7%)	18.1 (8.6%)
多価値不飽和	13.3 (6.7%)	13.7 (6.8%)	14.7 (6.9%)	14.8 (6.9%)	15.0 (7.0%)	14.4 (6.9%)
n-6PUFA	10.8 (5.4%)	11.0 (5.5%)	11.5 (5.4%)	11.3 (5.3%)	11.6 (5.4%)	11.3 (5.4%)
n-3PUFA	2.8 (1.4%)	2.9 (1.4%)	3.3 (1.5%)	3.4 (1.6%)	3.4 (1.6%)	3.2 (1.5%)
αリノレイン酸	1.8 (0.9%)	1.8 (0.9%)	2.0 (0.9%)	1.9 (0.9%)	2.0 (0.9%)	1.9 (0.9%)
EPA+DHA	1.0 (0.5%)	1.1 (0.5%)	1.3 (0.6%)	1.5 (0.7%)	1.4 (0.7%)	1.3 (0.6%)
n6/n3 ratio	4.0 ± 0.7	3.9 ± 0.8	3.7 ± 0.8	3.5 ± 0.9	3.5 ± 0.9	3.72 ± 0.9
コレステロール (mg/day)	299 ± 139	301 ± 139	334 ± 166	344 ± 1669	350 ± 174	329 ± 160
食塩 (g/day)	10.9 ± 3.6	11.1 ± 3.4	12.7 ± 4.3	13.2± 3.9	13.3 ± 4.2	12.5 ± 4.1

データは1日あたりの摂取量平均値±標準偏差を示す。3大栄養素は1日摂取量平均値(摂取総カロリーに占めるパーセント)で示す。

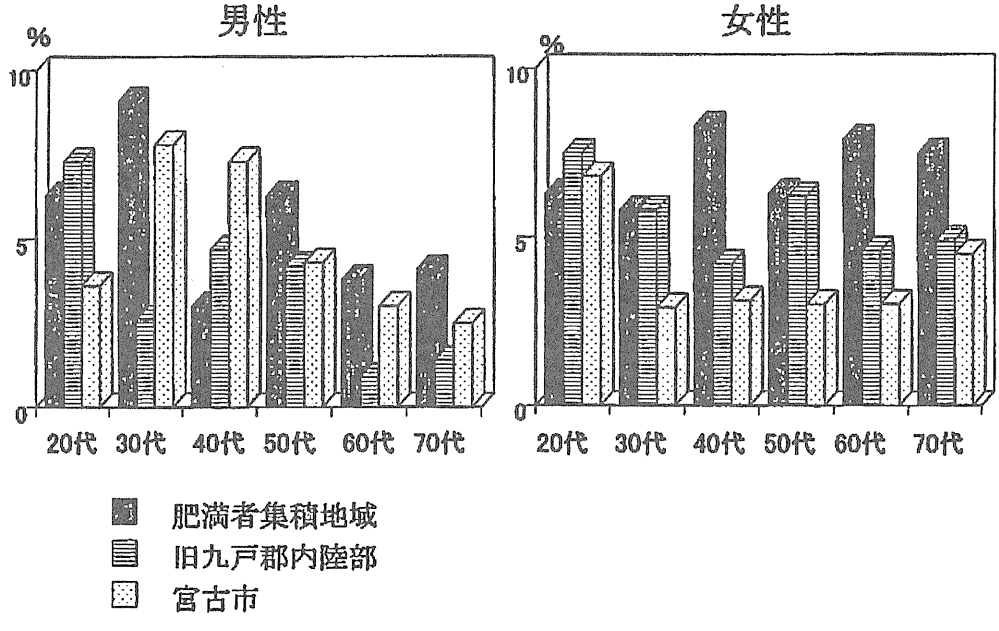

図2　3地域住民の年齢階級別高度肥満者割合（BMI−30）

図2は3地域（高度北部沿岸町村，九戸郡地域（軽米町・九戸村・大野村），宮古市の年齢階級別の高度肥満者（BMI−30）割合を示す。左が男性住民のグラフであり右側が女性住民のグラフを示す。男性では50歳以降で肥満者集積地域で高度肥満者割合が他の2地域に比べ高い傾向を示した。女性では，30代以降の全ての世代で肥満者集積地域では宮古市の肥満者割合と比べて30代以降の全ての世代で割合が高かった。同じ農村でも比較的肥満者割合が低かった旧九戸郡内陸3町村では，宮古市と肥満地域との中間の値を示していた。

図3は，肥満に影響を与えると考えられる運動習慣について3地域で年齢階級別に割合を示したものである。30−40代は勤務者が多く，岩手県北部全ての地域で共通して運動習慣をもつ者の割合が低く地域差が小さい。50代以降では運動習慣をもつ住民の割合に差が見られる傾向にある。肥満者集積地域では，50歳以上の男女は全ての年齢階級で運動習慣をもつ割合が低かった。特に，女性の運動習慣割合は肥満者集積地域では1割を下回っており，肥満者・高度肥満者が非常に多いことに関連していることが推測される。

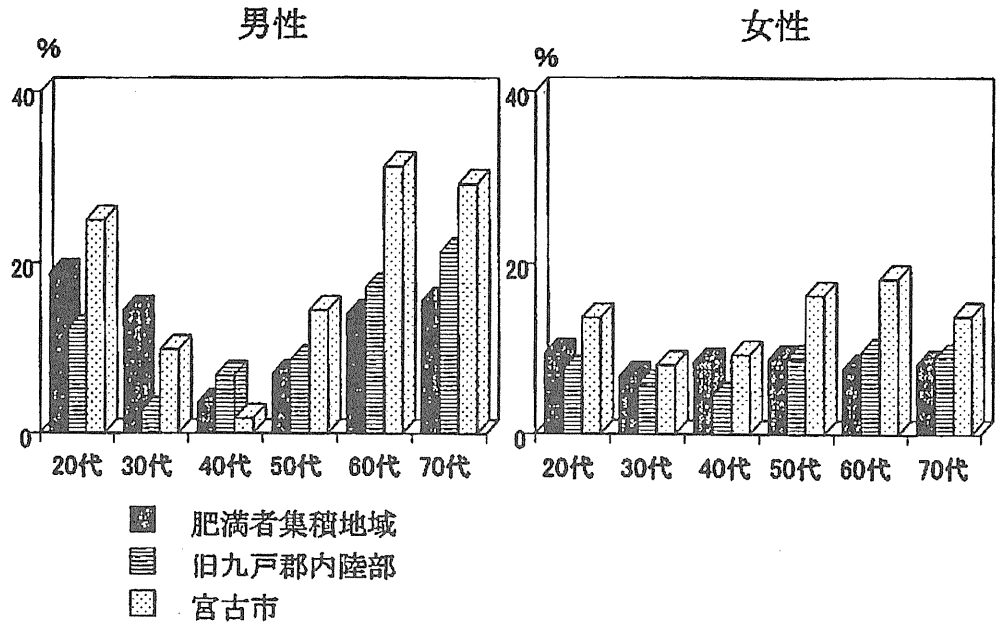

図3　3地域住民の年齢階級別運動習慣割合（1時間以上の運動を月8回以上）

図3は3地域（前述）の年齢階級別の運動習慣（1時間以上の運動を月8回以上）を持つ住民の割合を示す。男性では50歳以降の住民では宮古市とそのほかの2地域で明らかな差がみられ，最も運動習慣を持つ住民の割合が低かったのは肥満集積地帯であり，九戸郡の町村は宮古市と肥満地区の中間であった。女性では，全ての年齢階級で宮古市住民で運動習慣を持つ住民の割合が他の2地区より高かった。肥満地区と旧九戸郡内陸3町村では明らかな差はみられなかった。

4．考　察

板井らの論文の中で特に住民の肥満に焦点をあてた本考察では，1）同じ岩手県北部地域でも市町村によって住民の肥満者割合には大きな違いがみられること，2）肥満者割合の違いの地域差は女性でより顕著であること，3）肥満者割合は都市部より町村部でより高いこと，4）町村部でも特に北部陸中海岸沿岸地域と下閉伊郡内陸部で肥満者割合が高いこと，5）年齢階級別で見ると，全ての地域で20代の高度肥満者割合が日本の平均と比較して大きく上回っていること，6）肥満者集積地域では男女ともに全ての年齢階級で肥満者割合が一様に高く，その他の地域では中高年の高度肥満者割合が肥満者集積地域に比べ低かったこと，などが特徴としてあげられた。

上記問題点の中で1）から4）について考察してみる。肥満者が都市部よりも町村に多いこと，また沿岸北部地域町村に多いことの理由として，本研究では生活習慣の違いに焦点をあてて検討した。男女ともに肥満者が比較的少ない宮古市に比べて中年以上の住民では肥満者集積地域では運動習慣のある人の割合が小さかったことが特徴としてあげられた。食事内容を見ると，肥満者集積地域では食事に占める炭水化物摂取量が多い傾向がみてとれた。しかし，肥満者割合が比較的小さかった旧九戸郡内陸3町村住民と比較すると，運動習慣は肥満者集積地域ではやや低かったものの，栄養摂取内容に違いはみられず，今回の検討では肥満者集積地域と旧九戸郡内陸3町村地域との生活習慣の違いは明らかではなかった。また，比較対照とした宮古市住民のデータに着目すると，BMI 25以上の肥満者割合は第5次循環器疾患基礎調査で示された日本人全体の値に比べて高いこと[1]，30代・40代の男性の高度肥満者割合が7％を超えていることから，日本人の平均と比べると宮古市自体が肥満者割合の高い地域であり[7]，比較対照としては適切ではないことが示唆された。同じ岩手県でも社会環境，所得，産業構造が日本の平均

に近い盛岡市や盛岡市近郊の住民との比較により，肥満集積地帯のより明らかな特徴が導き出される可能性があると思われる。

年齢階級別の検討で大きな問題と考えられたのは，岩手県北部地域全ての地域に共通して20代の参加者の高度肥満者割合が高かったことである。都市部の宮古市では男性の高度肥満者割合がやや低かったものの，宮古市女性ならびに肥満者集積地域と旧九戸郡内陸3町村の両農村地域の男女ともに20代では，BMI30以上の高度肥満者割合が7％前後であった。これら20代の若者の高度肥満者が容易にやせるとは考えられないため，現状を放置したままでは将来の岩手県北部地域では高度肥満，高血圧症，糖尿病の有病率が非常に高い時代が到来することが予想される。まことに憂うべき状況と考えられる。

年齢階級別の特徴で際立っていたのは，肥満者集積地域では，30歳以上の全ての年齢階級で肥満者割合が高かったことである。日本全体の平均を見ると，肥満者割合は中年以降の男性で徐々に高くなる傾向にあり，女性の場合は中年まではそれほど高くならず，高齢女性で肥満者割合が高くなる傾向にある。しかも，男女ともにBMI30を越える高度肥満者割合は日本全体では少なく，せいぜい3％程度である[8]。一方岩手県北部地域では，北部沿岸の肥満者集積地域は40代以降ですべての年齢階級で高度肥満者割合が一様に高い傾向にあり，特に女性の高度肥満者割合が高かった。比較的肥満者割合の低かった旧九戸郡内陸3町村は，日本人の傾向とは逆に男女ともに高齢になるほど肥満者割合が低くなる傾向にあった。しかし若い世代の肥満者が多いことからこの地域でも将来は肥満の問題が大きく住民の健康問題に影響を及ぼすことが予想される。すなわち現在の肥満を抱える若い世代が加齢とともに高血圧症や糖尿病を発症するようになり，将来的には脳卒中や心筋梗塞などの循環器疾患発症率が上がる可能性があるからである。

上記地域の特徴を考慮するうえで運動や栄養摂取とは別に，地形や地域の産業構造，世帯構造，地域コミュニティーの状況についてより深く知る必要がある。全体を通してみると都市部に比べ町村部で肥満者が多かったが，岩手県北部内陸と北部沿岸を比較すると沿岸地域により肥満者が多い町村が存在する。沿岸地域の町村に着目すると，海岸沿いに平野が開け，比較的大きな集落が存在する山田町や野田村では肥満者が少ない傾向にあり，沿岸でありながら山地が海岸にまで迫っていて，急峻な山地にはさまれた狭隘な谷間に小さな集落が散在している田老町，岩泉町，普代村などでは肥満者が多かった。また同じ内陸でも人口集積規模が大きい二戸市と集積規模が小さく山間に集落が散在する一戸町では，後者で肥満者が多かった（表1参照）。上記観察結果からは，狭隘な谷間の集落に住む住民は，平野の比較的大きな集落に住む住民に比べ肥満者がより多く存在している可能性を示唆する。

前述したように北部沿岸町村では運動習慣をもつ人の割合が中年以上の男女に共通して小さかった。しかし，運動習慣の有無だけが肥満者割合に寄与しているわけではなさそうである。同じ山村地域でも内陸の町村は沿岸の町村より肥満者割合は小さい。しかし，運動習慣をみると，旧九戸郡内陸3町村地区住民の運動習慣割合は肥満者集積地域である北部沿岸町村と比べてやや高い程度であり，このことが肥満者割合の大きな違いになって表れるとは考えにくい。また肥満者割合の地域差は女性でより顕著であり，女性の運動習慣割合は，3地域でそれほど大きな差はみられなかったのである。

肥満には食事摂取量と内容，運動による消費カロリーが関係する。従って栄養調査と運動習慣問診は肥満状況の要因把握にはぜひとも必要な調査である。しかし，今回の検討では，都市部と比較して山村に肥満者が多いこと，都市部と山村で運動習慣や食事の内容に違いがみられること，しかし，肥満者の多い山村と，肥満者の比較的少ない山村同士の比較では，明らかな生活習慣の違いが見出せなかったことが示された。今回の検討では，肥満割合には地域差が顕著に見られることが明示

されたが，その背景要因についてはより詳細な検討が要することが示唆された。具体的には，岩手県山村地域のように第一次産業に従事する人口が多い地域では[9]，スポーツなどの運動習慣とは別に日常の労働（農作業や土木作業）や生活動作に伴う運動内容（家事や歩行など）がより肥満の問題に大きく関わることを考える必要がある。人口が少ないということでは共通している北部沿岸の肥満者集積地域と旧九戸郡内陸3部ではあるが，地形には大きな違いがある。軽米町・旧大野村・九戸村では比較的広い平坦な土地に水田や畑が広がる田園地域を抱えるが，岩泉町・普代村：旧田老町・旧山形村は急峻な山地に囲まれ，坂の多い狭隘な盆地に小規模の集落が点在している。山間地域の中高年世代では，家の周辺の坂の多い道を歩くのも重労働であり，外出には家族の車を利用するのみで日常生活において歩く習慣さえも失われている可能性も考慮する必要がある。今回の検討では，日常生活に関わる運動に関しては十分な検討ができなかったことから，今後日常生活動作によって消費されるカロリーをも考慮した比較検討を試みたい。

栄養調査は食物摂取頻度法を用いた自記式問診法を採用している[6]。この手法は，摂取した栄養の相対的な比率を見出すには問題はない。即ち，摂取カロリーに占める炭水化物や脂肪の摂取比率は，肥満地区で炭水化物が高く，宮古市では脂肪が高かったことが明示された事に関して正確性において問題はないと思われる。しかし，栄養素の摂取総量絶対値の比較に関しては限界がある。栄養素摂取量の絶対値の大きさは肥満に直結する大きな問題であるが，肥満集積地域住民と宮古市民とで摂取総カロリーの絶対値の差があったかどうかはこの方法では厳密にはできない。よって両地区の本当の意味での食事摂取内容の違いを見るためには，実際に摂取した食事と同じ内容の食物を再現しての栄養内容分析（陰膳法）を専門の栄養研究者を交えて行うことも必要と思われる。今後の課題である。

5．結　論

岩手県北部地域住民の特色として，日本人全体と比較して肥満者が多く，特に男女ともにBMI30以上の高度肥満者が多いのが特徴であった。同じ岩手県北部地域でも肥満者の割合には大きな地域差が存在し，都市部と比較し山間部農村で肥満者割合が高かった。町村地区の比較では，旧九戸郡内陸3町村に比べ沿岸地区町村で肥満者割合が高かった。年齢階級別の比較では，全ての地域で20代の高度肥満者割合が高かった。30代以降を比較すると，肥満者集積地域ではどの年代でも高度肥満者割合が一様に高かったのに対し，宮古地域や二戸地域では中年以降で肥満地域に比べ高度肥満者割合が低くなる傾向にあり，このことが全体の肥満者割合の差となっていた。肥満者割合の地域差は女性でより顕著であった。肥満者集積地域では中年以降の世代で高血圧有病率，糖尿病有病率が宮古市住民と比較し高かった。

以上の結果から岩手県北部地域山村には高度肥満者が集積する地域があり，しかも肥満者集積地域では他の2地域と比較して高血圧症と糖尿病有病率が世代によっては有意に高率であることが示された。岩手県北部地域の農村住民の肥満糖尿病対策は緊急の課題であり，肥満に関連する要因を探るためのさらなる研究が必須である。明らかにされた肥満関連要因を分析して肥満問題を解決すべく具体的な対策立案ならびに実施が早急に望まれる。

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Cardiovascular risk factors in the Japanese northeastern rural population ☆

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Abstract

Background: People living in the northeastern part of Japan have high prevalences of hypertension and stroke. The current status of cardiovascular risk factors in them should be elucidated.
Methods: The survey was carried out from 2002 to 2004 in the northeastern part of the main island of Japan. A total of 26,472 Japanese men and women were enrolled (acceptance rate: 84.5%). Sex- and age-specific prevalences of cardiovascular risk factors were determined. Mean values of predictive markers (high-sensitivity C reactive protein (hsCRP), brain natriuretic peptide (BNP) and microalbuminuria) were also determined in each group. Risk factor-related variables in non-hypertensive subjects and hypertensive subjects were compared.
Results: Proportions of subjects with hypertension, diabetes and dyslipidemia were 46.0%, 7.6%, and 30.3%, respectively, in males and 38.6%, 4.0%, and 38.5%, respectively, in females. Mean values of hsCRP and BNP were 1.41 mg/L and 26.5 pg/mL, respectively, in males and 1.01 mg/L and 23.7 pg/mL, respectively, in females. Proportions of male and female subjects with microalbuminuria were 22.0% and 23.4%, respectively. These markers become higher with advance of age. Prevalence of atrial fibrillation was 1.56%, and it increased with advance of age in both men and women. High prevalences of cardiovascular risk factors in this area were found. Hypertensive subjects who did not take anti-hypertension medication accounted for about 20% of total subjects and their blood pressure remained poorly controlled.
Conclusion: Attention should be given to cardiovascular risk factors in the Japanese northeastern rural population.

Keywords: Cardiovascular risk factors; C-reactive protein; Brain natriuretic peptide; Microalbuminuria; Atrial fibrillation; The Iwate-KENCO study

1. Introduction

People living in the northeastern part of the main island of Japan (Tohoku area) have high prevalences of hypertension and stroke compared with those in people living in other areas [1,2] and they have a large intake of salt [3]. Attention should be given to the current status of cardiovascular risk factors in people living in this area of Japan.

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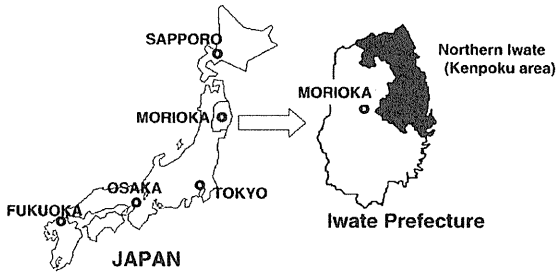

Fig. 1. The study area. This figure shows a map of Japan and a map of Iwate Prefecture. Iwate Prefecture is located in the northeastern part of the main island (Honshu Island) of Japan. The black area of Iwate Prefecture indicates the study area. Kenpoku means northern part of the prefecture in Japanese.

We have conducted a population-based prospective cohort study in the northeastern part of Japan. The aims of the present study were to determine the age- and sex-specific prevalences of cardiovascular diseases (CVD) and their risk factors by a cross-sectional analysis of data from the initial survey. We also compared cardiovascular risk factor-related characteristics in hypertensive subjects and non-hypertensive subjects to clarify the status of clustering risk factors in hypertensive subjects.

2. Subjects and methods

2.1. Study subjects

The "Iwate KENpoku COhort Study (Iwate-KENCO Study)" is a population-based prospective study in people living in the northeastern part of the main island of Japan (Fig. 1). The initial surveys were carried out from 2002 to 2004. Each survey was conducted from April to November. The study area is a typical rural area of Japan with a low move-out/move-in population, high proportion of people engaged in primary industry (18.4%) [4] and high proportion of elderly people (people aged 65 years or more: 26.2% of the total population). The study area consists of 17 municipalities, and the total population of the region in 2002 was 241,057. Invitations to multiphasic health screening were issued by government offices in the municipalities. A total of 31,318 people (11,003 men and 20,315 women) aged 18 years or older participated in annual health check-ups from 2002 to 2004 in the study area. Of those participants, 26,472 men and women gave written informed consent for participation in this study (acceptance rate: 84.5%). Sex- and age-specific numbers and proportions of participating subjects and acceptance rates are shown in Table 1. The study was approved by the Medical Ethics Committee of Iwate Medical University and conducted in accordance with the guidelines of the Declaration of Helsinki.

2.2. Measurements

Measurements of blood pressure were performed by well-trained staff. Weight was measured with an automated scale (TANITA digital scale Model BWB-200). Height was measured using a digital handle scale (YAGAMI model 48525YG-200D). Blood pressure was measured twice in the sitting position using an automatic device (BP-103i IIModel 513000, Nippon Colin, Komaki, Japan) after urination and a five-minute rest. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were each calculated as the mean of two measurements. Body mass index (BMI) was calculated as weight (kg) divided by the square of body height (m).

Self-administered questionnaires on demographic characteristics, history of cardiovascular disease and apoplexy, drug use, alcohol consumption, smoking, and exercise habit were used to collect individual information. Details were described previously [5].

A nutrition survey was carried out in each municipality. This survey was an optional survey and was carried out at each participant's own discretion (executing rate: 72.4%). Dietary habits during the previous month were assessed using a brief

Table 1
Age- and sex-specific numbers of participants, acceptance rates, and proportions of total population in the study area.

Age group	18–29	30–39	40–49	50–59	60–69	70–79	≥80	Total
Total population in the study area (*n*)	18,692	26,036	29,850	35,001	33,673	29,301	14,494	233,307
Participants of check-ups (*n*)	330	1302	3289	6449	11,038	8115	1078	31,318
Participants of the study (*n*)	266	1064	2793	5537	9376	6869	797	26,472
Acceptance rate (%)	80.6%	81.7%	84.9%	85.9%	84.9%	84.6%	73.9%	84.5%
Proportion of total population (%)	1.4%	4.1%	9.4%	15.8%	27.8%	23.4%	5.5%	11.3%
Total male population (*n*)	9326	12,940	15,019	17,113	15,081	12,475	4379	109,749
Participants of check-ups (*n*)	108	367	1005	1841	3930	3345	498	11,003
Participants of the study (*n*)	83	296	813	1520	3281	2863	385	9162
Acceptance rate (%)	76.9%	80.7%	80.9%	82.6%	83.5%	85.6%	77.3%	83.3%
Proportion of total population (%)	0.9%	2.3%	5.4%	8.9%	21.8%	22.9%	8.8%	8.3%
Total female population (*n*)	9366	13,096	14,831	17,888	18,592	16,826	10,115	123,558
Participants of check-ups (*n*)	214	935	2284	4608	7108	4770	580	20,315
Participants of the study (*n*)	180	768	1980	4017	6095	4006	412	17,310
Acceptance rate (%)	84.1%	82.1%	86.7%	87.2%	85.7%	84.0%	71.0%	85.2%
Proportion of total population (%)	1.9%	5.9%	13.4%	22.5%	32.8%	23.8%	4.1%	14.0%

Data are expressed as numbers or percentages.

self-administered diet history questionnaire (BDHQ). This is a 4-page structured questionnaire that consists of three sections: general dietary behavior and main cooking methods, consumption frequencies and amounts of intake of 5 alcoholic beverages, and frequencies of consumption of 50 selected food and nonalcoholic beverage items. Estimates of dietary intake of 48 food and beverage items, energy and nutrients were calculated using an ad hoc computer algorithm for the BDHQ, which was mainly based on the Standard Tables of Food Composition in Japan [6]. Results of validation study for the BDHQ were previously described in detail [7].

A resting 12-lead electrocardiogram was recorded in each participant after a five-minute rest. The electrocardiographic findings were independently evaluated by a trained clinical technician and a medical doctor in Iwate Health Service Association according to the original coding system developed by Iwate Health Association. In this study, sex- and age-specific prevalences of atrial fibrillation (AF) were determined. AF was defined according to the original coding system (including paroxysmal atrial fibrillation and atrial flutter).

2.3. Biochemical analyses

Casual blood samples were drawn from antecubital veins of seated participants. The samples were transported to a laboratory (Iwate Health Service Association) and analyzed on the same day.

Total cholesterol (TC) levels were determined by an enzymatic assay, triglyceride (TG) levels were determined by an enzyme-colorimetric assay, high-density lipoprotein cholesterol (HDLC) levels and low-density lipoprotein cholesterol (LDLC) levels were determined by a direct quantitative assay, and plasma glucose levels were determined by the hexokinase ultraviolet method. All of the above biochemical data were analyzed using an automated analyzer (HITACHI 7700). Glycosylated hemoglobin (HbA_{1c}) levels were determined by high-performance liquid chromatography using an automated analyzer (TOSOH HLC-723G7 Japan). Determinations of TC levels and HDLC levels were performed under the quality control program of the Center for Disease Control in the United States [5].

Serum levels of high-sensitivity C-reactive protein (hsCRP) were determined by the latex-enhanced immunonephelometric method (Dade Behring Diagnostics, Germany) with a threshold of 0.1 mg/L. In this estimation, hsCRP values under the minimum detectable level were regarded as being 0.1 mg/L. Plasma brain natriuretic peptide (BNP) levels were measured by a direct radioimmunoassay using monoclonal antibodies specific for human BNP (Shiono RIA BNP kit, Shionogi and Co., Ltd., Japan). Plasma BNP assays were performed for 65.6% of the subjects in the study. The method for measuring plasma BNP levels was previously described in detail [8].

Urine albumin was assessed quantitatively by an immunonephelometric method (N-antiserum albumin, Dade Behring) and urine creatinine was measured quantitatively by an enzymatic colorimetric test [9]. The urine albumin–creatinine ratio (UACR) was used since the accuracy of the ratio in comparison to a 24-hour urine sample has been demonstrated in previous studies [10,11].

2.4. Classification and definition

To examine to what extents traditional risk factors, dietary intake of nutrients and new predictive markers (hsCRP, BNP, and urine albumin) are associated with age in a cross-sectional analysis, we divided the participants into age-specific groups (18–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80 years or older) for both sexes. Hypertension was defined as SBP being 140 mmHg or higher, DBP being 90 mmHg or higher, use of antihypertensive agents or a combination of these. Diabetes mellitus (DM) was defined as plasma glucose level being 200 mg/dL or higher, plasma HbA_{1c} level being 6.5% or higher, use of anti-diabetes agents or a combination of these. Dyslipidemia was defined as serum TC level being 220 mg/dL or higher, serum HDLC level being less than 40 mg/dL, use of anti-hyperlipidemia agents or a combination of these. In current drinkers, regular alcohol drinking was defined as drinking five days or more per week and occasional drinking was defined as drinking less than five days per week. In non-current drinkers, subjects were divided into past drinkers and non-drinkers. Regular exercise was defined as doing exercise for at least 60 min eight days or more per month, and exercise habit was defined as doing exercise for at least 60 min per month. Overweight was defined as BMI being 25 kg/m^2 or more and obesity was defined as BMI being 30 kg/m^2 or more.

In most previous studies, subjects with high CRP level (10 mg/L or higher) were excluded to avoid analysis of data from subjects who had developed apparent inflammatory disease [12]. Both mean hsCRP level in all subjects and that in subjects after excluding subjects with hsCRP levels greater than 10 mg/L are shown in this study. We defined high BNP level as 50 pg/mL or more according to our previous study [8]. Macroalbuminuria was defined as UACR being 300 mg/g or more, and microalbuminuria was defined as UACR being 30 mg/g or more and less than 300 mg/g. To estimate the proportion of participants with microalbuminuria, subjects with macroalbuminuria were excluded.

2.5. Statistical analysis

Prevalences of risk factors were determined in each age- and sex-specific group. Mean values (standard deviations) of risk factor-related variables were also determined in each group. Linear trend tests were used to examine the association between age and each variable after adjusting for other traditional risk factors (SBP, BMI, TC, HDLC, HbA_{1c}, and current smoking status). Comparisons of hsCRP levels, BNP levels, and urinary albumin levels in men and women were performed using the Mann–Whitney U test. The chi-square test was used to compare the proportions of subjects between the groups. Sex difference in the prevalence of AF was tested after direct age adjustment.

Age-adjusted SBP, TC, HDLC, LDLC, and HbA_{1c} were compared between the three groups according to presence of hypertension (non-hypertensive subjects, hypertensive subjects with medication, hypertensive subjects without medication) using analysis of covariance (ANCOVA). Prevalences of overweight, obesity, DM, and dyslipidemia were also compared between the three groups using age-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) by logistic regression analysis.

All p values were based on two-sided tests, and p values less than 0.05 were considered to be statistically significant. The Statistical Package for Social Sciences (SPSS Japan Inc., version 14.0, Tokyo) was used for the analyses.

3. Results

Table 2 shows age- and sex-specific characteristics of participants with regard to demographic, biochemical and comorbid conditions. SBP and HbA_{1c} levels were higher with advance of age in both sexes (trend $p<0.01$). Prevalences of hypertension and DM were higher with advance of age in both sexes (trend $p<0.01$). The proportions of subjects with hypertension were more than 50% in males aged 50 years or older and in females aged 60 years or older. The proportions of subjects with dyslipidemia were about 30% in middle-aged males and about 40% in females aged 50 years or older. Prevalences of myocardial infarction and stroke were very low in both sexes.

Table 3 shows age- and sex-specific proportions of subjects with a smoking habit, drinking habit, and exercise habit. The proportion of current smokers in males aged 49 years or younger was more than 50%. The proportion of current smokers was very low in the female subjects, but it exceeded 15% in females aged 39 years or younger. The proportion of regular drinkers in middle-aged male subjects

Table 2
Age- and sex-specific prevalences of cardiovascular diseases and mean levels of their risk factor-related variables.

Age group Men (n)		18–29	30–39	40–49	50–59	60–69	70–79	≥80	Total	Trend	Sex difference
Men (n)		86	214	813	1520	3281	2863	385	9162		
BMI	(kg/m^2)	22.4 (3.8)	24.2 (3.5)	24.1 (3.1)	24.3 (3.0)	24.1 (2.9)	23.6 (3.0)	23.0 (2.9)	23.9 (3.0)		‡
BMI ≥ 25		25.6%	36.0%	34.9%	39.1%	36.3%	30.9%	21.3%	34.2%		
BMI ≥ 30		5.8%	5.6%	4.2%	4.2%	2.8%	2.2%	0.8%	3.0%		
SBP	(mmHg)	114.2 (11.6)	119.9 (15.7)	122.1 (16.4)	127.5 (19.0)	131.9 (19.7)	133.8 (19.5)	136.9 (20.7)	130.7 (19.6)	†	‡
TC	(mg/dL)	171.7 (35.6)	192.3 (36.7)	197.1 (36.2)	195.8 (32.2)	191.4 (32.0)	188.0 (31.3)	184.2 (30.4)	191.1 (32.5)		
TG	(mg/dL)	122.4 (85.6)	144.0 (97.1)	154.4 (106.6)	135.7 (93.5)	124.6 (83.3)	113.1 (68.8)	104.3 (54.1)	125.1 (83.6)		
HDLC	(mg/dL)	53.7 (13.4)	55.3 (13.9)	56.4 (15.6)	56.8 (15.5)	56.1 (15.4)	55.5 (15.2)	54.3 (13.4)	56.0 (15.2)		
LDLC	(mg/dL)	102.1 (33.5)	116.7 (32.7)	117.3 (32.5)	116.3 (29.4)	113.4 (29.4)	111.9 (27.6)	109.7 (27.5)	113.6 (29.3)		
PG	(mg/dL)	92.8 (14.6)	99.0 (30.1)	107.8 (35.9)	113.4 (35.4)	115.8 (34.6)	116.6 (36.7)	117.6 (34.5)	114.4 (35.5)	†	‡
HbA_{1C}	(%)	4.68 (0.30)	4.81 (0.49)	4.99 (0.81)	5.12 (0.74)	5.18 (0.73)	5.20 (0.74)	5.17 (0.63)	5.14 (0.74)	†	
MI		0.0%	0.0%	0.0%	0.1%	0.8%	1.4%	1.3%	0.8%		‡
Stroke		0.0%	0.0%	0.1%	0.3%	0.4%	0.7%	0.3%	0.4%		‡
DM		0.0%	0.9%	3.8%	6.7%	8.4%	9.1%	7.8%	7.6%	†	‡
HTN		0.0%	10.7%	21.4%	35.4%	50.0%	55.9%	61.6%	46.0%	†	‡
DL		22.1%	30.4%	33.0%	33.3%	30.1%	29.0%	27.0%	30.3%		
Women (n)		180	620	1980	4017	6095	4006	412	17,310		
BMI	(kg/m^2)	21.7 (4.3)	22.5 (3.7)	23.4 (3.6)	24.0 (3.4)	24.3 (3.4)	24.3 (3.5)	24.0 (3.5)	24.0 (3.5)		
BMI ≥ 25	(%)	13.9%	22.1%	28.0%	35.1%	39.9%	40.4%	34.8%	36.5%		
BMI ≥ 30	(%)	6.7%	4.8%	5.3%	5.5%	5.5%	6.0%	3.5%	5.5%		
SBP	(mmHg)	102.1 (11.1)	107.5 (14.1)	115.1 (16.8)	121.9 (19.3)	127.9 (19.4)	132.3 (19.6)	135.3 (20.7)	125.2 (20.1)	†	
TC	(mg/dL)	167.8 (29.0)	176.5 (30.0)	192.3 (31.6)	209.6 (32.7)	209.4 (30.8)	206.3 (30.3)	201.2 (33.1)	205.0 (32.4)		
TG	(mg/dL)	75.7 (69.3)	89.3 (62.5)	98.2 (77.4)	112.1 (68.3)	117.5 (64.6)	117.5 (62.7)	113.2 (54.5)	112.5 (66.9)		
HDLC	(mg/dL)	62.7 (14.6)	63.3 (14.1)	63.6 (14.5)	63.0 (14.4)	60.4 (14.2)	59.6 (14.3)	58.6 (13.4)	61.2 (14.4)		
LDLC	(mg/dL)	95.1 (26.7)	100.8 (26.1)	113.1 (28.2)	126.1 (29.7)	127.0 (27.8)	124.8 (27.0)	121.5 (28.1)	123.3 (28.9)		
PG	(mg/dL)	90.7 (11.9)	94.1 (14.3)	100.7 (22.2)	104.4 (25.0)	108.0 (26.9)	110.9 (28.3)	116.6 (33.6)	106.5 (26.5)	†	
HbA_{1C}	(%)	4.65 (0.28)	4.75 (0.41)	4.88 (0.52)	5.08 (0.64)	5.16 (0.66)	5.21 (0.62)	5.23 (0.72)	5.10 (0.63)	†	
MI		0.0%	0.0%	0.0%	0.0%	0.2%	0.6%	1.7%	0.3%		
Stroke		0.0%	0.2%	0.2%	0.2%	0.3%	0.2%	0.7%	0.2%		
DM		0.0%	0.2%	1.8%	3.0%	4.3%	5.9%	7.5%	4.0%	†	
HTN		0.6%	4.2%	12.3%	28.5%	43.5%	58.7%	63.8%	38.6%	†	
DL		8.9%	9.4%	20.9%	41.0%	44.2%	42.2%	35.9%	38.5%		

Data are expressed as means (standard deviations) or percentages. †, $p<0.05$ by linear trend test. ‡ means significantly higher than that in the other sex, and p value (<0.05) was estimated by Student's t-test or the chi square test. Abbreviations: BMI, body mass index; SBP, systolic blood pressure; TC, total cholesterol; TG, triglyceride; HDLC, high-density lipoprotein cholesterol level; LDLC, low-density lipoprotein cholesterol level; PG, casual plasma glucose; HbA_{1c}, percentage of glycosylated hemoglobin; MI, myocardial infarction; DM, diabetes mellitus; HTN, hypertension; DL, dyslipidemia.

Table 3
Age- and sex-specific cardiovascular risk factors: proportions of subjects with smoking, alcohol drinking, and exercise habits.

Age group	18–29	30–39	40–49	50–59	60–69	70–79	≥80	Total	Trend	Sex difference
Men (*n*)	86	214	813	1520	3281	2863	385	9162		
Smoking status										
Current	57.0%	58.9%	55.0%	41.4%	27.6%	21.9%	16.6%	31.1%	†	‡
Ex-smoker	4.7%	14.0%	23.0%	25.5%	31.0%	38.0%	37.1%	31.2%	†	‡
Non-smoker	38.4%	27.1%	22.0%	33.2%	41.5%	40.1%	46.2%	37.8%		
Drinking habit										
≥5 days/week	26.7%	51.4%	55.2%	54.9%	46.1%	38.1%	29.4%	45.1%		‡
<5 days/week	32.6%	26.6%	23.1%	22.8%	24.0%	20.7%	17.7%	22.6%		‡
Non-drinker	39.5%	17.8%	19.4%	18.0%	21.1%	28.3%	40.0%	23.6%		
Ex-drinker	1.2%	4.2%	2.2%	4.3%	8.9%	12.9%	13.0%	8.8%		‡
Exercise habit										
≥60 min*8 times/month	17.4%	8.4%	5.3%	9.8%	20.0%	21.2%	22.9%	17.2%		‡
≥60 min/month	37.2%	29.9%	25.7%	30.2%	40.6%	42.9%	41.6%	38.0%		
Women (*n*)	180	620	1980	4017	6095	4006	412	17,310		
Smoking status										
Current	21.7%	15.2%	7.0%	3.4%	1.1%	0.7%	0.0%	2.9%	†	
Ex-smoker	11.7%	9.4%	4.4%	1.2%	0.6%	0.5%	0.5%	1.6%	†	
Non-smoker	66.7%	75.5%	88.6%	95.4%	98.4%	98.8%	99.5%	95.5%		
Drinking habit										
≥5 days/week	7.8%	11.9%	9.8%	4.5%	3.0%	1.9%	2.9%	4.2%	†	
<5 days/week	34.4%	36.5%	27.4%	19.1%	11.4%	6.7%	4.4%	14.9%	†	
Non-drinker	48.9%	48.1%	60.9%	74.4%	84.5%	90.4%	91.3%	79.3%		
Ex-drinker	8.9%	3.5%	1.9%	2.0%	1.1%	0.9%	1.5%	1.5%		
Exercise habit										
≥60 min*8 times/month	11.1%	6.3%	7.1%	10.8%	12.1%	10.2%	11.4%	10.6%		
≥60 min/month	26.1%	26.1%	27.1%	33.9%	35.8%	33.0%	29.6%	33.1%		

Proportions are expressed as percentages.
†and ‡ are explained in Table 2.

was more than 50%. The proportions of subjects doing regular exercise were 17.2% in males and 10.6% in females. Among persons aged 30 to 59 years, the proportion of subjects doing regular exercise was less than 10% in both sexes.

Table 4 shows age- and sex-specific mean levels of daily dietary intake of nutrients. Thé most notable characteristic in this study population is a very high level of dietary intake of salt in middle-aged and elderly people. Dietary intake of salt was about 13 g/day in males aged 39 years or younger and became higher with advance of age, exceeding 16 g/day in males aged 60 years or older. Dietary intake of salt was about 10 g/day in females aged 39 years or younger. It also became higher with advance of age and exceeded 13 g/day in females aged 60 years or older.

Mean dietary intake of carbohydrate (percent of total energy) was about 55% in both sexes. Mean dietary intake of fat was about 23% in males and it was 25% in females. Dietary intake of saturated fatty acid was about 6% in males and it was about 7% in females. Dietary intake of monounsaturated fatty acid was about 8% in males and it was about 9% in females. Ratios of n-6PUFA to n-3PUFA in the diet were 3.3 in males and 3.4 in females. The ratio exceeded 4.0 in subjects aged 39 years or younger in both sexes, but the ratio became lower with advance of age (trend $p<0.05$).

Table 5 shows age- and sex-specific mean levels of hsCRP, ,BNP, urinary albumin , and UACR. Mean hsCRP levels were 0.92 mg/L in males and 0.75 mg/L in females after excluding subjects with apparent inflammation. Levels of hsCRP were positively associated with age in both sexes (trend $p<0.01$). Levels of hsCRP in males were higher than those in females ($p<0.05$).

BNP levels were positively associated with age in both sexes (trend $p<0.01$). Crude BNP levels were higher in men than women in total subjects ($p<0.01$), but they were lower in male subjects aged less than 60 years than in females aged less than 60 years ($p<0.01$). Our data showed that about 16% of total subjects aged 60–69 years, 20% of total subjects aged 70–79 years and more than 40% of total subjects aged 80 years or more had BNP levels of 50 pg/mL or higher in both sexes.

Mean crude urinary albumin concentration and mean UACR in the male subjects were 45.6 mg/L and 54.7 mg/g, respectively, and those in females were 25.2 mg/L and 39.5 mg/g, respectively. Macroalbuminuria was seen in 3.1% of total male subjects and in 1.6% of female subjects. After excluding subjects with macroalbuminuria, proportions of subjects with microalbumimnuria were less than 10% in the 18 to 39 years age group and 10–20% in the 40 to 59 years age group in both sexes. Both prevalence of microalbuminuria and

Table 4
Age- and sex-specific mean levels of daily dietary intake of nutrients.

Age group	18–29	30–39	40–49	50–59	60–69	70–79	≥80	Total	Trend	Sex difference
Men (*n*)	69	182	679	1255	2550	1399	175	6309		
Total energy kcal/day	2500±783	2436±803	2585±802	2611±823	2480±786	2369±755	2397±877	2489±796		‡
CHD g/day (%)	358.2 (57.4%)	342.8 (56.3%)	363.3 (56.5%)	361.4 (55.5%)	339.8 (55.1%)	321.9 (54.7%)	319.3 (53.9%)	342.4 (55.3%)		
Protein g/day (%)	83.6 (13.4%)	81.2 (13.5%)	85.9 (13.4%)	94.2 (14.5%)	97.3 (15.7%)	97.8 (16.5%)	101.8 (16.9%)	95.1 (15.3%)		
Fat g/day (%)	63.8 (23.0%)	58.6 (21.9%)	58.0 (20.3%)	62.4 (21.4%)	63.3 (22.8%)	64.9 (24.3%)	71.3 (26.2%)	63.0 (22.6%)		
SFA	16.6 (6.0%)	15.5 (5.8%)	14.5 (5.1%)	15.7 (5.4%)	15.8 (5.7%)	16.1 (6.1%)	17.6 (6.5%)	15.7 (5.7%)		
MUFA	22.1 (8.0%)	20.3 (7.6%)	19.9 (7.0%)	21.1 (7.2%)	21.2 (7.6%)	21.7 (8.1%)	24.2 (8.8%)	21.2 (7.6%)		
PUFA	16.9 (6.1%)	15.2 (5.7%)	15.8 (5.5%)	16.8 (5.8%)	17.2 (6.2%)	17.7 (6.6%)	19.4 (7.1%)	17.1 (6.1%)		
n-6PUFA	14.0 (5.1%)	12.2 (4.6%)	12.4 (4.4%)	12.7 (4.4%)	12.6 (4.5%)	12.9 (4.8%)	14.4 (5.3%)	12.7 (4.6%)		
n-3PUFA	3.5 (1.3%)	3.2 (1.2%)	3.5 (1.2%)	4.0 (1.4%)	4.2 (1.5%)	4.4 (1.6%)	4.7 (1.7%)	4.1 (1.5%)		
αlinolenic acid	2.3 (0.8%)	2.0 (0.7%)	2.1 (0.7%)	2.1 (0.7%)	2.1 (0.8%)	2.2 (0.8%)	2.5 (0.9%)	2.2 (0.8%)		
EPA+DHA	1.2 (0.4%)	1.2 (0.5%)	1.4 (0.5%)	1.8 (0.6%)	2.1 (0.7%)	2.2 (0.8%)	2.2 (0.8%)	1.9 (0.7%)	†	
n6/n3 ratio	4.2±1.0	4.0±0.8	3.8±0.9	3.4±0.9	3.2±0.9	3.2±1.0	3.3±1.0	3.3±1.0	†	
Cholesterol mg/day	353±148	355±152	375±181	416±210	431±220	443±232	480±271	423±218		‡
Salt g/day	13.8±5.2	13.3±4.6	14.4±4.8	15.8±5.5	16.6±5.4	16.9±5.6	17.5±6.4	16.2±5.5	†	
Women (*n*)	152	558	1795	3473	4825	1908	138	12,849		
Total energy kcal/day	1645±492	1753±503	1784±499	1804±530	1854±580	1820±583	1758±576	1818±553		
CHD g/day (%)	230.4 (55.9%)	245.8 (56.2%)	251.3 (56.6%)	257.1 (57.4%)	263.3 (57.4%)	259.5 (57.8%)	254.2 (58.7%)	258.1 (57.3%)		
Protein g/day (%)	58.7 (14.3%)	64.4 (14.7%)	67.8 (15.2%)	72.0 (15.9%)	77.4 (16.6%)	75.7 (16.5%)	72.9 (16.4%)	73.5 (16.1%)		
Fat g/day (%)	49.4 (26.9%)	51.6 (26.4%)	52.6 (26.3%)	52.4 (25.8%)	53.9 (25.7%)	52.9 (25.5%)	50.3 (24.9%)	53.0 (25.8%)		
SFA	14.4 (7.8%)	14.3 (7.3%)	14.0 (7.0%)	13.6 (6.7%)	13.8 (6.6%)	13.5 (6.5%)	12.9 (6.4%)	13.7 (6.7%)		
MUFA	16.8 (9.2%)	17.6 (9.0%)	18.0 (9.0%)	17.6 (8.6%)	17.9 (8.5%)	17.6 (8.4%)	16.7 (8.2%)	17.7 (8.6%)		
PUFA	11.8 (6.5%)	12.9 (6.6%)	13.5 (6.8%)	13.8 (6.8%)	14.4 (6.9%)	14.2 (6.9%)	13.3 (6.6%)	14.0 (6.8%)		
n-6PUFA	9.7 (5.3%)	10.5 (5.4%)	10.7 (5.3%)	10.4 (5.1%)	10.6 (5.1%)	10.5 (5.1%)	9.7 (4.8%)	10.5 (5.1%)		
n-3PUFA	2.4 (1.0)	2.7 (1.2)	3.0 (1.3)	3.2 (1.6)	3.5 (1.8)	3.4 (1.8)	3.2 (1.9)	3.3 (1.7)		
αlinolenic acid	1.6 (0.9%)	1.7 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.8 (0.9%)	1.7 (0.8%)	1.8 (0.9%)		
EPA+DHA	0.8 (0.4%)	1.0 (0.5%)	1.2 (0.6%)	1.4 (0.7%)	1.6 (0.8%)	1.6 (0.8%)	1.5 (0.7%)	1.5 (0.7%)	†	
n6/n3 ratio	4.2±0.8	4.0±0.8	3.8±0.9	3.4±0.9	3.3±1.0	3.3±1.0	3.3±1.0	3.4±1.0	†	
Cholesterol mg/day	293±122	304±132	317±137	328±162	350±181	347±184	341±174	336±169		
Salt g/day	9.6±3.0	10.8±3.4	11.5±3.5	12.5±4.1	13.6±4.5	13.6±4.6	13.3±4.6	12.8±4.3	†	

Data are expressed as means±standard deviations. Amount of daily intake of dietary variables (carbohydrate, protein and fat) are expressed as means (percentages of total energy). †and ‡ are explained in Table 2.
Abbreviations: CHD, carbohydrate; SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; n6/n3 ratio, ratio of n-6PUFA to n-3PUFA in the diet.

mean UACRs were positively associated with age in both sexes (trend $p<0.01$).

Table 6 shows age- and sex-specific prevalences of AF. For comparison with prevalences of AF in other studies, results of National Surveys in Japan [13], the CHF study [14], a study in Minnesota [15], and a study in Australia [16] are also shown. Prevalence of AF in subjects aged 18 years or older in this study was 1.56%. Prevalence of AF increased with advance of age in both men and women (from 0.1% in subjects younger than 40 years of age to 4.2% in subjects aged 80 years or older). Prevalence of AF in males aged 18 years or older was higher than that in females aged 18 years or older (3.29% vs 0.64%, $p<0.001$), and all age-specific prevalences of AF in males except for prevalences in the 20's and 80's groups were significantly higher than those in females (p values <0.001).

Table 7 shows a comparison of risk factors in non-hypertensive subjects and hypertensive subjects (with or without medication). Since mean age was higher in hypertensive subjects than in non-hypertensive subjects, comparison of each variable between the groups was performed after age adjustment. Blood pressure control was acceptable in hypertensive subjects taking anti-hypertension medication, while it was poorly controlled in hypertensive subjects without medication (mean SBP levels: 151.9 mmHg in men and 150.5 mmHg in women). Prevalences of obesity and DM were significantly higher in hypertensive subjects than those in non-hypertensive subjects after age adjustment (all p values <0.05).

4. Discussion

Cross-sectional analysis in this study revealed sex- and age-specific prevalences of hypertension, dyslipidemia, diabetes, and obesity in the general population living in a rural area of the northeastern part of Japan. The analysis also showed proportions of smokers, regular drinkers and subjects who do regular exercise.

Table 5
Age- and sex-specific mean levels of new predictive markers (hsCRP, BNP, UACR).

Age group		18–29	30–39	40–49	50–59	60–69	70–79	≥80	Total	Trend	Sex difference
Men											
hsCRP	(*n*)	83	211	799	1500	3218	2776	371	8958		
Crude mean	(mg/L)	0.95 (2.84)	0.83 (1.95)	0.87 (1.87)	0.96 (2.15)	1.43 (4.80)	1.72 (5.91)	2.25 (7.53)	1.41 (4.78)	†	‡
Exclude high CRP[a]	(*n*)	82	210	795	1487	3158	2710	355	8797		
Crude mean	(mg/L)	0.66 (1.08)	0.71 (0.97)	0.77 (1.16)	0.80 (1.16)	0.94 (1.25)	1.01 (1.32)	1.13 (1.35)	0.92 (1.25)	†	‡
BNP (*n*)		46	131	597	1028	2134	1789	242	5967		
Crude mean	(pg/mL)	3.5 (5.8)	5.8 (6.6)	7.4 (9.4)	14.1 (21.6)	24.9 (34.4)	38.1 (56.2)	71.0 (117.9)	26.5 (47.1)	†	‡
High BNP[b]	(%)	0.0%	0.0%	0.8%	3.8%	10.9%	20.7%	47.5%	12.8%	†	‡
U-Alb (*n*)		83	211	796	1494	3199	2763	361	8907		
Crude mean	(mg/L)	10.9 (11.4)	30.0 (122.7)	28.5 (137.5)	35.0 (136.8)	46.2 (228.9)	53.9 (179.1)	74.9 (208.7)	45.6 (189.3)	†	‡
UACR	(mg/g)	8.4 (7.9)	24.5 (90.8)	27.8 (136.0)	37.3 (122.9)	56.4 (265.7)	67.5 (257.5)	101.0 (340.0)	54.7 (235.1)	†	‡
Exclude macroalbuminuria[c]		83	208	788	1462	3097	2656	336	8630		
Crude mean	(mg/L)	10.9 (11.4)	18.8 (37.9)	17.6 (34.8)	20.7 (34.0)	24.1 (42.7)	29.3 (48.6)	34.3 (55.4)	24.7 (43.2)	†	‡
UACR	(mg/g)	8.4 (7.9)	15.1 (32.7)	16.7 (28.4)	22.8 (36.1)	26.5 (40.0)	32.3 (44.6)	35.2 (43.7)	26.7 (40.1)	†	
% of microalbuminuria[d]		1.2%	6.7%	10.2%	18.3%	22.0%	28.1%	31.8%	22.0%	†	
Women											
hsCRP	(*n*)	179	618	1953	3955	5977	3893	395	16,970		
Crude mean	(mg/L)	0.70 (1.70)	0.78 (2.32)	0.72 (1.94)	0.86 (2.88)	1.07 (3.00)	1.23 (3.75)	1.27 (2.66)	1.01 (3.03)	†	
Exclude high CRP[a]	(*n*)	177	612	1940	3920	5895	3832	387	16,763		
Crude mean		0.56 (1.16)	0.61 (1.04)	0.60 (1.06)	0.68 (1.04)	0.78 (1.11)	0.86 (1.17)	0.97 (1.35)	0.75 (1.11)	†	
BNP	(*n*)	79	319	1415	2743	4003	2599	240	11,398		
Crude mean	(pg/mL)	8.3 (7.4)	9.6 (9.0)	13.9 (13.5)	16.1 (15.9)	23.8 (22.9)	35.7 (35.0)	58.9 (60.1)	23.7 (26.8)	†	
High BNP[b]	(%)	0.0%	0.3%	1.8%	2.5%	9.2%	21.2%	42.1%	9.8%	†	
U-Alb	(*n*)	176	610	1932	3918	5938	3856	385	16,815		
Crude mean	(mg/L)	17.0 (43.6)	14.5 (36.9)	17.7 (74.4)	17.9 (59.5)	24.7 (85.3)	36.5 (136.0)	52.9 (111.2)	25.2 (93.2)	†	
UACR	(mg/g)	16.9 (55.7)	16.6 (36.5)	23.3 (83.5)	28.7 (86.5)	39.9 (131.1)	58.0 (205.0)	87.4 (249.0)	39.5 (141.3)	†	
Exclude macroalbuminuria[c]		175	607	1916	3884	5841	3754	364	16,541		
Crude mean	(mg/L)	14.3 (23.2)	12.8 (26.3)	13.6 (23.9)	14.2 (24.3)	17.6 (26.9)	22.9 (31.0)	34.3 (45.6)	17.7 (27.8)	†	
UACR	(mg/g)	12.9 (19.5)	14.8 (25.7)	17.8 (27.0)	22.5 (31.2)	28.2 (36.6)	35.2 (41.2)	47.2 (53.2)	27.0 (36.2)	†	
% of microalbuminuria[d]		6.3%	6.1%	12.0%	17.2%	24.8%	34.7%	47.0%	23.4%	†	

Data are expressed as means (standard deviations) or percentages. †and ‡ are explained in Table 2. Abbreviations: hsCRP, high-sensitivity c-reactive protein; (*n*), number of participants; BNP, Brain natriuretic peptide; U–Alb, urine albumin concentration; UACR, urine albumin-creatinine ratio.
[a] Excluding high hsCRP level (≥10 mg/L).
[b] Proportion of high BNP level (≥50 pg/mL).
[c] Excluding macroalbuminuria (UACR ≥300 mg/g).
[d] Proportion of microalbuminuria (≥30 mg/g).

The results of a nutrition survey in the study indicated that attention must be given to dietary intake of salt. The incidence of stroke is higher in Japan than in the US and northern European countries [17], the prevalence of hypertension is higher and dietary intake of salt in Japan is also higher than that in other countries [2,17,18]. The results of our study indicate that the problem of excessive dietary intake of salt in the rural area in northeastern Japan should be resolved immediately.

This study provided sex- and age-specific mean levels of new predictive markers in the Japanese northeastern population. To our knowledge, there is no report on estimated sex- and age-specific levels of new predictive markers in apparently healthy subjects in a large population (>10,000 subjects). There were several interesting findings in this study. First, levels of new predictive markers in elderly people were significantly higher than those in middle-aged persons, and we should pay attention to the significant difference in each marker between middle-aged and elderly persons. Cut-off points should be determined with consideration given to generation difference in each predictive marker.

With regard to hsCRP levels, the mean level in each age group was about 0.1 mg/L in both sexes. Male subjects had higher hsCRP levels than those in females. Levels of hsCRP in this study were lower than those in western people. Previous studies in the Japanese general population also showed lower hsCRP levels in Japanese people than those in western people and they also showed lower levels in female subjects [19].

A few studies have shown sex- and age-specific levels of BNP in the general population [20–22]. Redfield et al. determined plasma BNP levels in a total of 2042 subjects in Minnesota [21]. They used two analytical methods: Biosite and Shionogi (the same method as that used in our study). They showed that BNP levels increased with age and were higher in

Table 6
Age- and sex-specific prevalences of atrial fibrillation in this study and other studies.

Age group	30–35	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	≧80	Trend	Sex difference
Men													
Iwate	0.5%		0.7%		1.3%		3.2%		5.2%		5.5%	†	‡
Japan National Surveys	0.1%		0.3%		0.7%		1.3%		3.8% (≧70)				
CHS study	–	–	–	–	–	–	–	5.9%	5.8%	5.8%	8.0%		
Australia	–	–	–	–	–	–	1.1%	3.3%	8.6%	15.0%	15.0%		
Minnesota	–	0.0%		0.5%		1.0%			6.0%	16.1%			
Women													
Iwate	0.0%		0.1%		0.2%		0.5%		1.4%		3.0%	†	
Japan National Surveys	0.0%		0.1%		0.4%		0.9%		2.2% (≧70)				
CHS study	–	–	–	–	–	–	–	2.8%	5.9%	5.9%	6.7%		
Australia	–	–	–	–	–	–	2.3%	2.7%	5.5%	8.4%	8.4%		
Minnesota	–	0.0%		0.5%		1.5%		3.0%		12.2%			

Sex- and age-specific prevalences are expressed as percentages.
†, $p<0.05$ by linear trend test. ‡ means significantly higher than that in the other sex after direct age adjustment.

women than in men. They also showed the median level in each age group (45–54, 55–64, 65–74, and 75–83 years) separately by sex. However, the skewed distribution of BNP levels and small number of subjects in each age group (2 to 194 subjects) made it difficult to determine mean levels and ranges of each group. We showed age- and sex-specific mean levels of BNP without excluding any subjects. Moreover, our data revealed that sex difference in BNP levels inverted at the age of 60 years. Male subjects less than 60 years of age had lower levels of BNP than those in female subjects in the same age group, but male subjects aged 60 years or older had higher levels of BNP than those in females. The reasons why younger males had lower BNP levels and why older males had higher levels of BNP than those in females are unclear.

Presence of microalbuminuria is a significant predictor for development of CVD [23–28]. The proportions of persons with microalbuminuria in a general population or in subjects without heart failure have been estimated in several studies.

Table 7
Comparison of risk factors in non-hypertensive subjects and hypertensive subjects (with/without medication).

	Male subjects			Female subjects		
	HTN (−)	HTN (+) and Med (+)	HTN (+) and Med (−)	HTN (−)	HTN (+) and Med (+)	HTN (+) and Med (−)
Subjects (*n*)	4899	2277	1843	10,568	4210	2376
Age (means±SDs)	61.1±12.5	68.6±7.8	65.2±10.1	57.9±11.9	67.4±8.1	64.3±9.5
Age-adjusted mean levels of each variable (95% confidence interval). Estimated variables for persons aged 60 years						
SBP (mmHg)	118.4 (118.0–118.8)	137.2 (136.6–137.8)	151.2 (150.6–151.8)	115.3 (115.0–115.6)	133.8 (133.3–134.2)	150.5 (150.0–151.1)
BMI (kg/m^2)	23.5 (23.4–23.6)	25.0 (24.9–25.1)	24.3 (24.2–24.8)	23.3 (23.3–23.4)	25.4 (25.3–25.5)	24.7 (24.6–24.8)
TC (mg/dL)	191.1 (190.2–192.0)	191.1 (190.0–192.5)	195.6 (194.1–197.1)	204.0 (203.4–204.6)	202.4 (201.4–203.5)	209.4 (208.1–210.7)
HDLC (mg/dL)	56.0 (55.6–56.4)	55.5 (54.8–56.2)	57.0 (56.3–57.7)	62.2 (61.9–62.5)	59.7 (59.3–60.2)	60.6 (60.0–61.2)
LDLC (mg/dL)	114.3 (113.5–115.1)	112.7 (111.4–114.0)	115.3 (113.9–116.6)	122.3 (121.7–122.9)	121.6 (120.6–122.5)	127.2 (126.1–128.4)
HbA_{1C} (%)	5.09 (5.07–5.11)	5.16 (5.13–5.19)	5.13 (5.10–5.17)	5.06 (5.05–5.07)	5.17 (5.15–5.19)	5.09 (5.07–5.12)
Proportions of subjects with each risk factor (%) and age-adjusted odds ratios (ORs) and 95% confidence intervals (CIs)						
BMI≧25	28.2%	44.3%	37.3%	27.8%	53.8%	44.6%
OR (95%CI)	1.0	2.4 (2.1–2.7)	1.7 (1.5–1.9)	1.0	2.9 (2.7–3.2)	2.0 (1.9–2.2)
BMI≧30	2.1%	4.5%	3.4%	3.0%	10.6%	7.6
OR (95%CI)	1.0	3.4 (2.5–4.7)	2.1 (1.5–3.0)	1.0	4.8 (4.1–5.7)	3.1 (2.5–3.7)
DM	5.9%	11.1%	8.0%	2.7%	7.0%	4.2%
OR (95%CI)	1.0	1.8 (1.5–2.1)	1.3 (1.1–1.6)	1.0	2.1 (1.7–2.5)	1.3 (1.0–1.6)
DL	29.9%	30.7%	30.9%	35.6%	41.7%	45.4%
OR (95%CI)	1.0	1.1 (1.0–1.2)	1.1 (1.0–1.2)	1.0	1.0 (0.9–1.1)	1.3 (1.2–1.4)

Data are expressed as means±standard deviations, or age-adjusted means (95% confidence intervals), proportions (percentages), or age-adjusted odds ratios (ORs). Age-adjusted means (95% CIs) of continuous variables were estimated by using ANCOVA. Age-adjusted ORs (95%CIs) were estimated by logistic regression analysis. Abbreviations: MED (+), subjects with medication; MED (−), subjects without medication. Other abbreviations are the same as those in Table 2.

Foster et al. showed that the proportion of persons with microalbuminuria was 12.2% in a general population from the data of Framingham Offspring Cohort Study [29]. Bramlage et al. reported that 19.0% of 39,125 patients who visited primary-care practices had microalbuminuria [30]. These two studies showed that the presence of microalbuminuria increased with an increase in SBP. In our study, prevalences of microalbuminuria in male subjects and female subjects were 22.0% and 23.4%, respectively. Mean levels of UACR and proportions of microalbuminuria increased with advance of age after adjusting for risk factors (SBP, BMI, TC,HDLC, HbA_{1c}, and smoking). In our study, male subjects less than 60 years of age had higher levels of UACR than those in female subjects in the same age group, but male subjects aged 60 years or older had lower levels of UACR than those in females. Crude mean levels of urinary albumin were higher in men than in women in all age groups. This phenomenon may be attributable to lower levels of urinary creatinine in elderly women. Thus, attention should be given to possible overestimation in elderly women.

This study provided sex- and age-specific prevalences of AF in a rural area of northeastern Japan. A previous study showed that age- and sex-specific prevalences of AF in adults in Japan were lower than those in western countries in both sexes [13]. Age- and sex-specific prevalences of AF in males in this study are similar to those in the CHF study [14] and lower than those in other studies in western countries [15,16]. Sex- and age-specific prevalences in females in this study were lower than those in the Japan National Survey and in western countries [14–16]. The higher prevalence of AF in males in the present study than that in the National Survey in Japan [13] may be due to high prevalence of predisposing factors for AF, such as hypertension, diabetes, and obesity, compared to the prevalence of those factors in past national surveys in Japan.

Comparison of risk factors between three groups (non-hypertensive subjects, hypertensive subjects with medication, hypertensive subjects without medication) revealed that there was well-controlled blood pressure in subjects with medication and poorly controlled blood pressure in subjects without medication in the study area. Hypertensive subjects who did not take anti-hypertension medication accounted for about 20% of total subjects and their blood pressure remained poorly controlled. Moreover, hypertensive subjects with or without medication have higher prevalences of obesity, DM, and dyslipidemia than those in non-hypertensive subjects. The risk for future development of CVDs in subjects with hypertension is expected to be very high. These findings indicate the need for activities to prevent future development of CVD in the study area.

We tried to compare CVD risk factor-related variables in subjects in the present study and subjects in the Japan National Survey. Since there was a significant difference in age distribution between the two populations, we tried to show proportions of subjects having hypertension in each sex-and age-specific group. However, sex-and age-specific proportion of subjects in each blood pressure category was expressed as percentage without consideration of subjects with/without medication in the Japan National Survey [2,3]. Simple comparison of each sex- and age-specific prevalence of elevated blood pressure (SBP $\geq$ 140 or DBP $\geq$ 90) between our study and the Japan national surveys showed that proportions of subjects with elevated blood pressure were lower in our study than those in the Japan national surveys (data are not shown). This comparison appears to be meaningless. Comparison should be done with due consideration of the proportion of subjects taking anti-hypertension medication. Nonetheless, more than half of the people aged 60 years or older living in the study area have hypertension, and we should pay attention to cardiovascular morbidity and mortality in this area.

Several limitations to our study should be noted. A single instance of blood sampling may be susceptible to short-term variation. Since determination of dietary variables was based on a self-administered questionnaire, levels of dietary intake of energy and each nutrient estimated by a computer algorithm are not always consistent with true absolute values. However, it is reasonable to compare levels of dietary intake of nutrients in several groups when estimations of dietary intake of nutrients have been performed in a unified way. Persons who did not participate in the annual health check-ups were probably in poor condition and might have had CVD. These factors might have reduced the number of participants with CVD in this study; thus, the prevalences of CVD including hypertension, MI, stroke, and AF might be underestimated.

In conclusion, the results of this study showed high prevalences of cardiovascular risk factors in the study area. Attention should be given to cardiovascular risk factors, especially in people living in a rural area of northeastern Japan, in order to prevent future development of CVD.

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M.O. had full access to all data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology [31].

Appendix A. Members of the Iwate-KENCO Study

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Predictive value of plasma B-type natriuretic peptide for ischemic stroke: A community-based longitudinal study

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ABSTRACT

Objective: Structural heart diseases including atrial fibrillation are precursors for ischemic stroke. Plasma B-type natriuretic peptide (BNP) has been reported to be increased in patients with several types of structural heart diseases. However, the predictive value of plasma BNP for ischemic stroke remains unknown. We have studied the predictive ability of plasma BNP for future development of stroke in community dwelling adults.

Methods: Subjects of this community-based study were recruited from the general population (n = 13,466). Plasma BNP levels and cardiovascular risk factors were determined at baseline. The incidence of ischemic stroke in the cohort was identified from regional stroke registry data. A multivariate Cox regression analysis was performed to analyze the relationship between plasma BNP levels and the risk of stroke.

Results: During a mean follow-up period of 2.8 years, 102 participants (65 males, 37 females) experienced a first ischemic stroke. In men, after adjustment for classical cardiovascular risk factors and atrial fibrillation, the hazard ratio (HR) for ischemic stroke was significantly elevated in the highest plasma BNP quartile (HR = 2.38; 95% CI = 1.07–5.29). In women, the relationship between plasma BNP levels and risk of ischemic stroke was of marginal significance after adjusting for the presence or absence of atrial fibrillation (HR = 3.03; 95% CI = 0.84–10.92, P = 0.09).

Conclusion: Elevated plasma BNP levels predict the risk of ischemic stroke within men from the general population.

1. Introduction

B-type natriuretic peptide (BNP) is a cardiac hormone secreted from the myocardium in response to changes in intracardiac volume and pressure [1,2]. Plasma BNP levels are known to be elevated in patients with symptomatic left ventricular systolic dysfunction [3,4] and correlate to New York Heart Association (NYHA) class as well as prognosis [5,6]. In addition, irrespective of the degree of left ventricular dysfunction, plasma BNP levels have been shown to be elevated in patients with various structural heart diseases including previous myocardial infarction, cardiomyopathy, valvular heart disease, hypertensive heart disease, and atrial fibrillation [3,7–13].

These structural heart diseases are precursors not only for heart failure, but also for ischemic stroke, and especially cardioembolic stroke [14]. However, there have been very few reports on the association between plasma BNP levels and the risk of stroke. The Framingham Heart Study [15] has described a 4.9-fold increase in the crude incidence of stroke or transient ischemic attack in the highest tertile of BNP levels compared to the lowest tertile. Kistorp et al. [16] reported that plasma levels of N-amino terminal fragment of the prohormone BNP (NT-proBNP) predicted the risk of stroke or transient ischemic attack, with a 3.6-fold increase in risk of stroke for participants with values above the 80th percentile vs those with values equal to or below the 80th percentile in the general population. However, the association between plasma BNP levels and risk of stroke subtypes remains unclear. The predictive value of plasma BNP measurement for ischemic stroke remains unknown.

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We have studied the predictive ability of plasma BNP for future development of ischemic stroke in community dwelling adults.

2. Methods

2.1. Study population

The Iwate-Kenpoku Cohort (Iwate-KENCO) study was designed to prospectively investigate the risk of cardiovascular diseases including stroke and malignant tumor in the general Japanese adult population as described previously [17,18]. Subjects consisted of residents of the Ninohe, Kuji and Miyako districts in the northern Iwate prefecture, Japan. Between April 2002 and January 2005, 26,469 of these residents (men = 9161, women = 17,308) who were participating voluntarily in a multiphasic health checkup agreed to join the study (original cohort). The baseline survey included routine anthropometrical measurement, blood pressure measurement, ECG, routine laboratory assessment, a self-administered lifestyle questionnaire, and a food-frequency questionnaire. This study protocol was approved by our institutional ethics committee. All participants gave written informed consent.

Of the original cohort living in the Ninohe and Kuji districts (n = 15,927), 15,394 subjects (men = 5288, women = 10,106) underwent BNP measurement (BNP cohort). Subjects were excluded from this cohort on the basis of the following characteristics: age under 40 years (n = 575), history of cardiovascular or cerebrovascular events (n = 507), non-measurement of adjustment factors (n = 846). The final statistical analysis was therefore performed in 13,466 subjects (men = 4527, women = 8939, mean age = 62.7 years).

2.2. Outcome

In this cohort study, the primary endpoint was all-cause death, in addition to any nonfatal cardiovascular events such as myocardial infarction, cerebral infarction, or other strokes. Information about death and emigration was obtained from local government records. Stroke events were identified by accessing the Iwate prefecture stroke registration programme, which has been conducted since 1991 by the Iwate Medical Association with the support of the government of the Iwate prefecture [19]. Registration forms were submitted to the registration office of the Iwate Medical Association by mail when a patient with stroke was discharged from a medical facility. Diagnostic criteria for stroke used by the registry correspond with those published by the World Health Organization, based on a definition of sudden onset of neurological symptoms [20]. For diagnosis of stroke subtypes, computed tomography and/or magnetic resonance imaging were performed within each hospital. In order to improve accuracy of registration, trained research nurses checked medical charts in all hospitals located within these districts. Follow-up was conducted until August 2007.

2.3. Measurement

At the time of baseline survey, participants underwent anthropometrical measurement, ECG, blood pressure measurement, and routine laboratory assessment. In addition, a self-administered questionnaire was used to ascertain family history, symptoms, and lifestyle factors such as smoking habits, alcohol consumption, and exercise habits. A medical history including the status of drugs prescribed for hypertension, hyperlipidemia, diabetes, angina, myocardial infarction, congestive heart failure, and stroke was recorded by trained research staff. Using a 3-channel device, a standard 12-lead ECG was recorded in a supine position. Atrial fibrillation was defined by this 12-lead ECG at the time of baseline survey. Systolic and diastolic blood pressures were determined with an automatic device placed on the right arm of seated subjects who had rested in a sitting position for at least 5 min before measurement. Measurement was performed twice, with the mean value used for statistical analysis. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg, and/or current anti-hypertensive therapy. Hyperlipidemia was defined as total cholesterol level ≥240 mg/dL, and/or current lipid lowering therapy. Diabetes was defined as non-fasting glucose concentration ≥200 mg/dL, and/or glycosylated hemoglobin (HbA1c) value ≥6.5%, and/or current anti-diabetic therapy. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). Smoking was defined as current smoker. Regular alcohol consumption was defined as drinking alcohol 5 days or more per week. Regular exercise was defined as exercising (at least 60 min) 8 days or more per month.

Venous blood samples for plasma BNP measurement were drawn from the antecubital vein of seated participants with minimal tourniquet use. Samples were collected into vacuum tubes containing ethylenediaminetetraacetic acid sodium. Tubes were stored in an icebox immediately after sampling and were transported to our laboratory within 8 h of collection. These were then centrifuged at 1500 × g for 10 min. After separation, plasma samples were stored frozen at −20 °C until the time of assay. Plasma BNP levels were measured by direct radioimmunoassay using monoclonal antibodies specific for human BNP (ShionoRIA BNP, Shionogi, Japan) within 4 months of separation. The intraassay and interassay coefficients of variation were 5% and 6%, respectively. The lower detection limit of the assay was 0.05 pg/mL. Enzymatic methods were used to measure serum total cholesterol levels, serum creatinine, and blood glucose. HbA1c was measured quantitatively with an HPLC method.

2.4. Statistical analysis

Participants were divided into quartiles according to their baseline plasma BNP levels. Continuous variables were expressed as mean ± SD. Group comparisons were based on the unpaired t-test and multiple group comparisons across BNP quartiles were based on the one-way analysis of variance. Because BNP values were not normally distributed, these were expressed as median and the Mann–Whitney U-test was used for comparison. Categorical parameters were expressed as proportions (percentage) and group comparisons were based on the chi-square test.

The ischemic stroke event free rates according BNP quartiles were estimated using the Kaplan–Meier method, followed by Log-rank test. A multivariate Cox regression analysis was performed to analyze the relationship between plasma BNP levels and risk of stroke. For all models, the hazard ratios were adjusted for age, BMI, blood hemoglobin levels, serum creatinine levels, presence or absence of hypertension, hyperlipidemia, diabetes, smoking, regular alcohol consumption, and regular exercise. The analysis was not adjusted for presence or absence of atrial fibrillation in Model 1 and was adjusted in Model 2. Additional multivariate Cox regression analysis using covariates in Model 1 was performed using 1 SD increments in natural logarithm-transformed BNP values. For the analysis of stroke incidence, person-years were censored at the date of stroke diagnosis, the date of emigration from the study area, the date of death, or the end of the follow-up period, whichever came first. All statistical analysis was performed using SPSS software, version 11.0. A significant difference was defined as $P < 0.05$.

3. Results

Baseline characteristics of participants by sex are shown in Table 1. The mean age of men was higher than that of women. The percentages of hypertension, diabetes, atrial fibrillation, smoking, regular alcohol consumption, regular exercise, and mean values for