下または死亡するリスクが低いことが明らかになった。おそらく骨粗鬆症が介在するADL低下が関連しているものと考えられ、中年期におけるカルシウム摂取の強化も介護予防対策として重要なものと考えられる。

NIPPON DATA研究ではこれまで、循環器疾患死亡リスクに関する分析結果の集積をもとに、年齢・性別・血圧値・血清総コレステロール値・糖尿病の有無・喫煙習慣の有無から10年後の循環器疾患（および脳卒中・冠動脈疾患）の死亡確率を予測するリスク評価チャートを作成してきた。日本人を代表する集団の将来リスクを予測するこのチャートは、全国の実地医家、保健医療従事者、および一般国民に広く活用可能なものとして普及し、また、日本動脈硬化学会ガイドラインなどにも取り入れられ活用されている。本研究班ではさらに、ADL低下リスクに関する分析結果をもとに、ADL低下リスク評価チャートを作成することを大きな目的としてきた。最終年度に、これまでの分析においてADL低下リスクと強い関連を示した血圧値及び喫煙習慣の有無を予測因子としたADL低下評価チャートを試作した。このチャートを健康管理、介護予防、および医療の現場における健康教育・保健指導に役立てることができればと考えている。今後は、本研究で明らかになった食塩摂取量やカルシウム摂取量など食生活要因によるADL低下リスク評価チャートの作成も進めてゆきたい。

わが国国民における健康寿命の延伸のための対策立案において、国民の循環器疾患死亡リスクに関連する食生活要因を明らかにしてゆくことは大変重要である。3年間にわたる今回の研究において、従来のNIPPON DATA80およびNIPPON DATA90の2つの国民代表集団コホートに、ベースライン時に実施された国民栄養調査結果が結合された意義は極めて大きい。これにより国民栄養調査成績とその後20年以上の長期にわたる死因別死亡リスクとの関連が初めて可能となった。特にこれまでの国内外の多くのコホート研究において分析が困難であった食塩摂取量に関する分析が可能となった点は重要である。今回、国民栄養調査による信頼性の高い食塩摂取量と将来の循環器疾患死亡リスクとの関連が示唆されたが、この知見は国内のみならず世界的に見ても貴重なものである。国内外における循環器疾患予防のための減塩対策の重要性を改めて示す知見といえる。

このほか、日本人における野菜・果物摂取量、食物繊維摂取量、カルシウム摂取量等が、循環器疾患死亡リスクに予防的に関連することも明らかになった。今後さらに詳細な分析を進め、一つ一つ論文化してゆくことによって、日本人における循環器疾患予防の栄養面でのエビデンスとして確立してゆきたい。

本研究の成果の一つとして、循環器疾患死亡リスクと関連が強かった食塩摂取量および野菜・果物摂取量によって、将来の循環器疾患死亡リスクを予測するチャートを試作した。従来の、循環器危険因子を用いたNIPPON DATAリスク評価チャートに加え、食生活要因による循環器疾患リスク評価チャートとして、健康教育、保健指導、医療の現場、および一般国民に広く活用いただければと考えている。

E．健康危険情報

該当なし

F．研究発表

1．論文発表

（本報告書の末尾にリスト掲載）

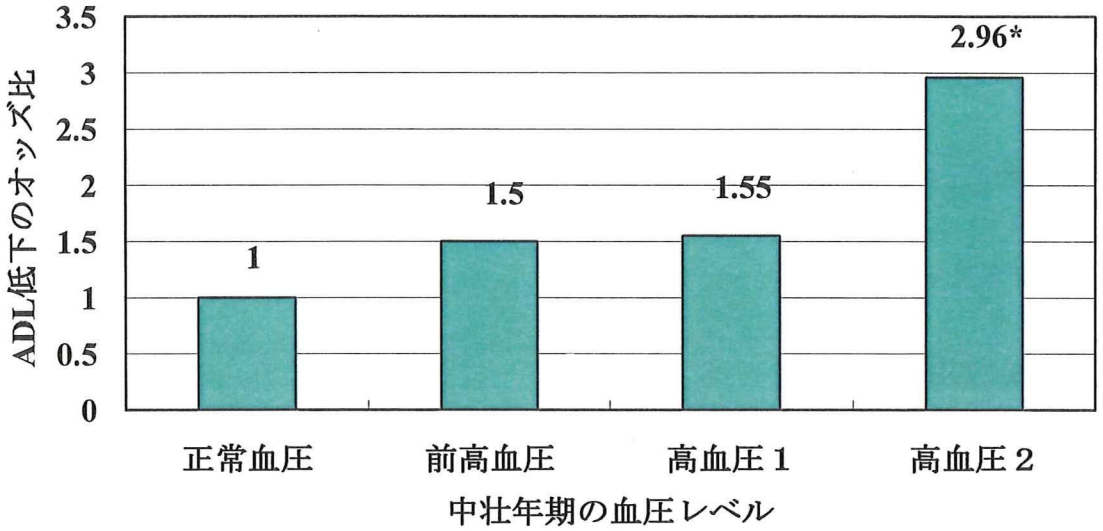
2．学会発表

（本報告書の末尾にリスト掲載）

G．知的財産権の出願・登録状況

該当なし

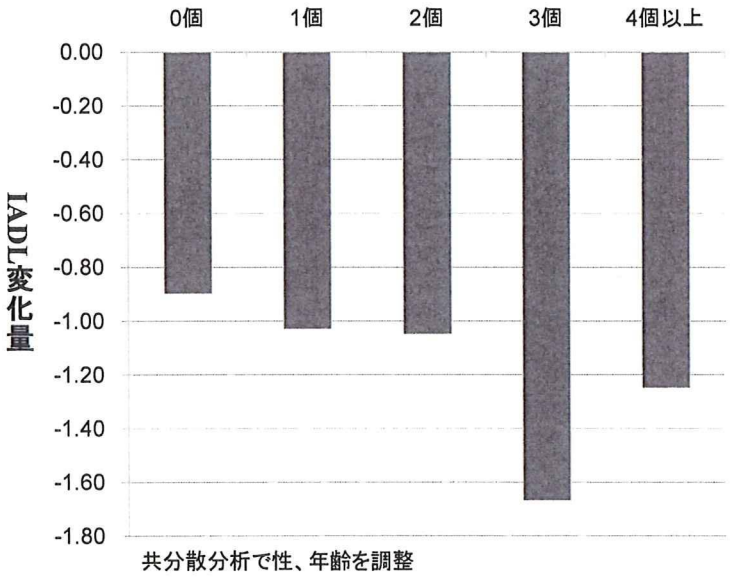
図１．中壮年期の血圧レベルと19年目のADL低下リスクとの関連： NIPPON DATA80



性、年齢、BMI、喫煙、飲酒、糖尿病、血清コレステロール、血清アルブミンを調整したオッズ比

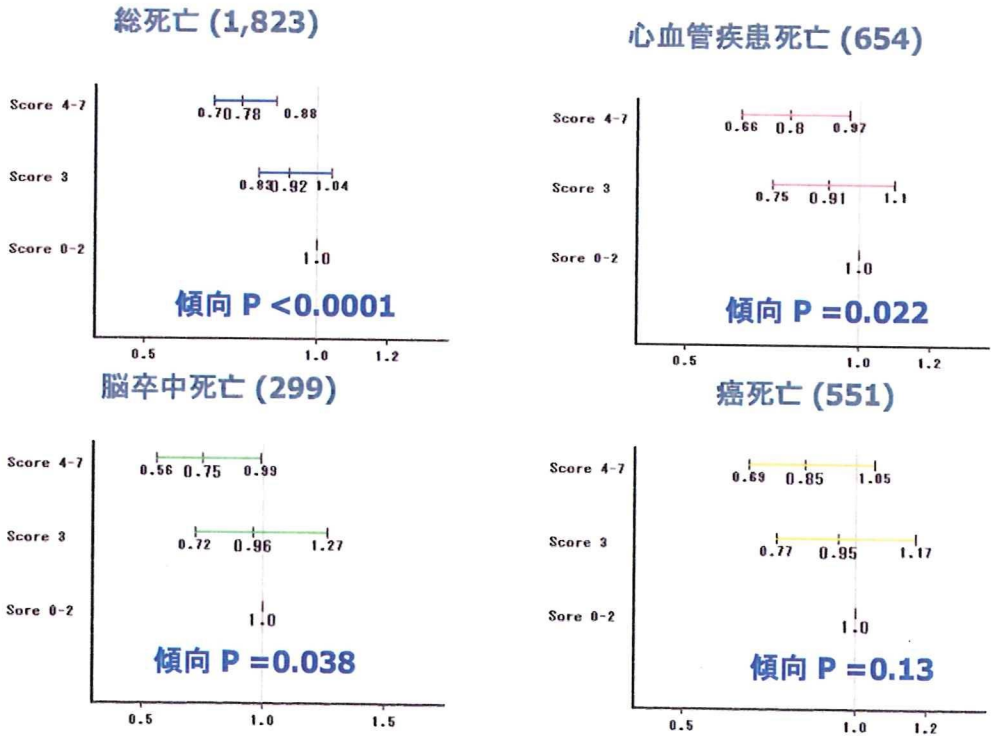
Hozawa A, et al. *J Hum Hypertens* 2009

図２．危険因子集積（喫煙、高血圧、糖尿病、高コレステロール、高中性脂肪、低 HDL コレステロール、肥満）と５年間の手段的 ADL 変化量： NIPPON DATA90



Hayakawa T, et al. *J Atheroscl Thromb* 2010;17:64-72

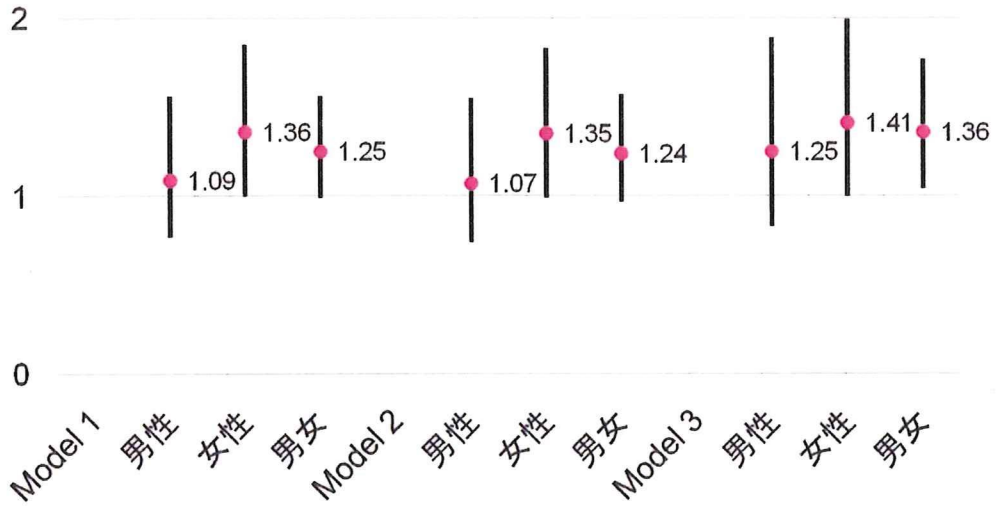
図３．健康的日本食スコアと総死亡、死因別死亡リスクとの関連：NIPPON DATA80 19年の追跡



Cox比例ハザードモデルにより年齢、性、BMI、喫煙、高血圧、糖尿病を調整したハザード比

Nakamura Y, et al. *Br J Nutr* 2009

図４．食塩摂取量の増加に伴うADL低下の調整オッズ比（ナトリウム摂取密度(mg/1000kcal)１標準偏差上昇あたり）：NIPPON DATA80の14年目の追跡



Model 1: 年齢、（性）を調整
Model 2: 年齢、（性）、BMI、アルブミン、喫煙を調整
Model 3: 年齢、（性）、BMI、アルブミン、喫煙、カリウム摂取量を調整

図５．中壮年期の血圧、喫煙習慣による19年目のADL低下リスク評価チャート

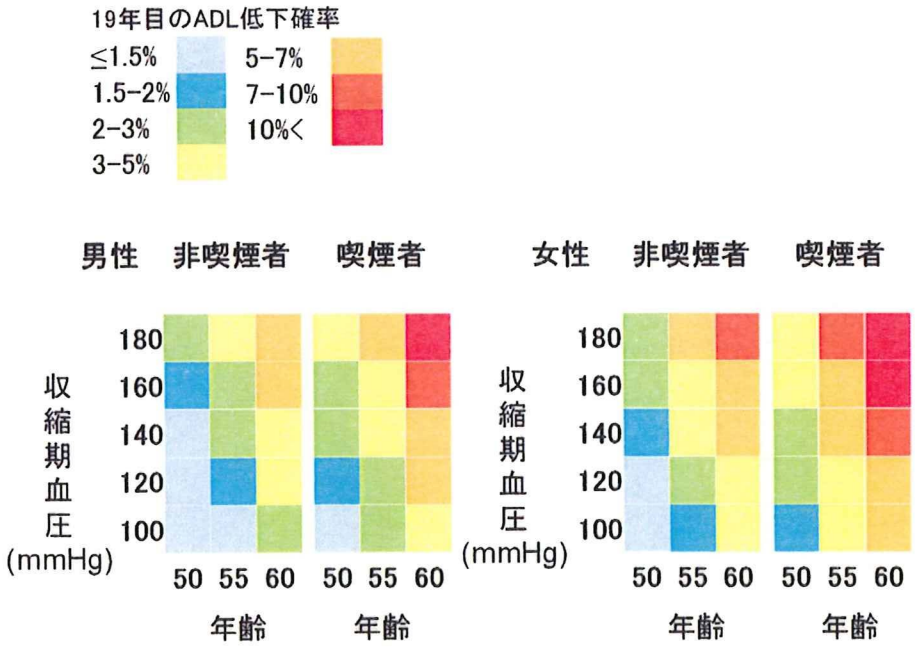
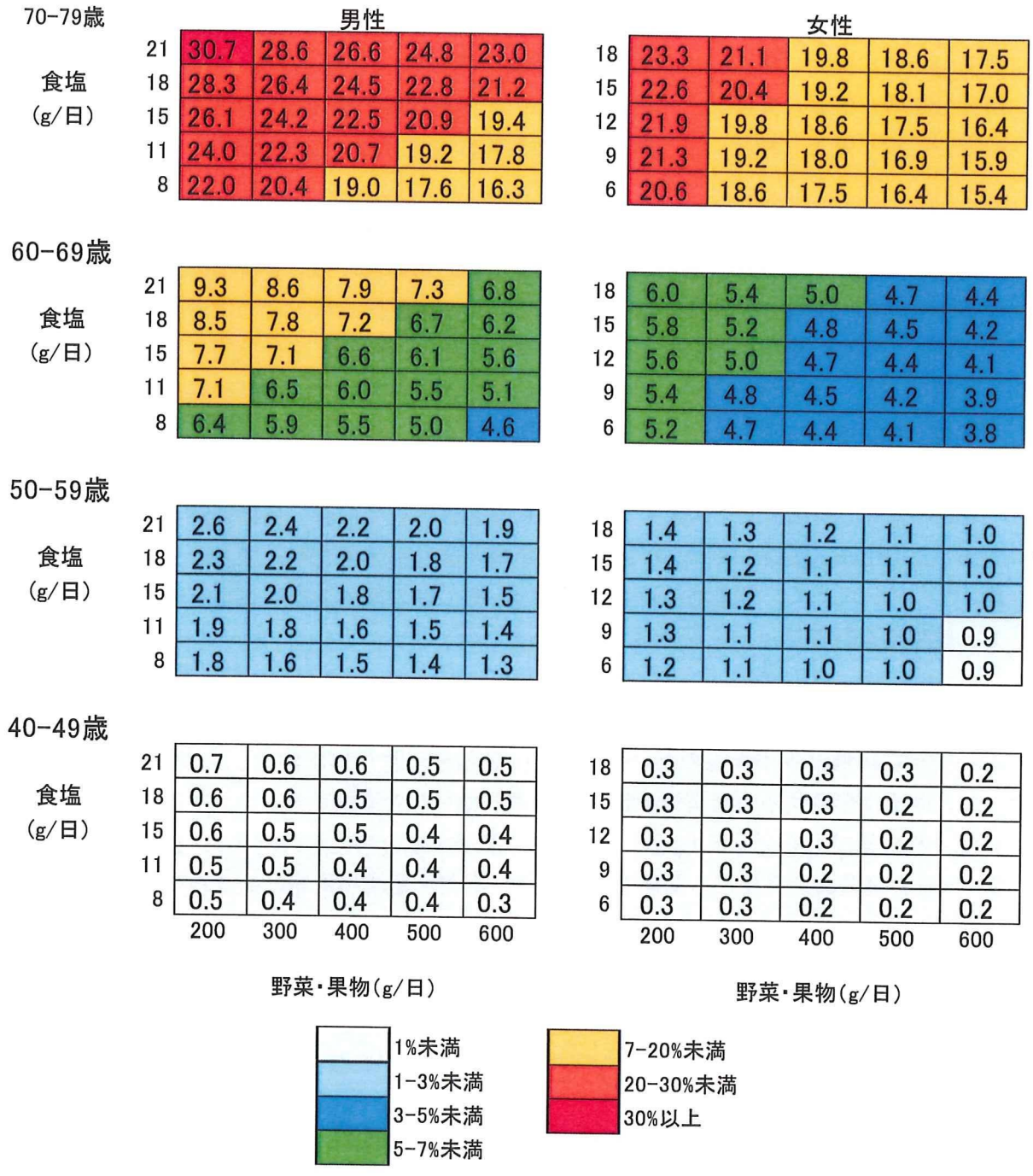


図６．食塩摂取量と野菜・果物摂取量を用いた10年以内の循環器疾患死亡リスク評価チャート：NIPPON DATA80



食生活要因による循環器疾患死亡リスク評価チャート

研究分担者　奥田　奈賀子　（滋賀医科大学社会医学講座公衆衛生学部門　特任助教）
研究代表者　上島　弘嗣　（滋賀医科大学生活習慣病予防センター　特任教授）
研究分担者　三浦　克之　（滋賀医科大学社会医学講座公衆衛生学部門　教授）
研究分担者　岡山　明　（財団法人結核予防会第一健康相談所　所長）
研究分担者　笠置　文善　（財団法人放射線影響研究所疫学部　副部長）
研究分担者　児玉　和紀　（財団法人放射線影響研究所　主席研究員）

目的　高血圧、脂質異常症、糖尿病、等の循環器疾患危険因子は、高齢者の健康寿命を阻害する要因として重要である。第二次世界大戦後の本邦では、食習慣の西洋化を経験するとともに、脳卒中死亡率が大幅に低下するなど循環器疾患死亡の構造変化も経験してきた。こうした死亡率の変化には、食習慣の変化が循環器疾患危険因子への影響を介して関連していると考えられ、本邦国民における食物摂取状況の循環器疾患死亡に対する影響を検討することにより、元気で長生きできる食生活のあり方を明らかにすることができる。

本研究では、本邦国民を代表する循環器疾患基礎調査受検者の長期追跡コホート研究であるNIPPON DATA 80・29年追跡調査結果と国民栄養調査結果統合データセットを用いて、ベースライン調査時点の食生活要因とその後の循環器疾患死亡との関連を検討し、健康寿命評価チャートを作成することとした。

方法　NIPPON DATA80追跡対象者で栄養摂取データを有する者のうち、ベースライン調査時に循環器疾患既往のない、男性4,032名と女性5,173名とした。食生活要因として、血圧に影響する生活習慣要因として重要である食塩摂取量と、カリウム摂取あるいは食物繊維摂取を介して血圧や血清脂質に関連すると考えられる野菜・果物摂取量と、24年後の循環器疾患死亡の関連を検討した。野菜・果物摂取量は緑黄色野菜、その他の野菜と果物摂取量の合計とした。Cox比例ハザードモデルを用いて、1980年時の食塩(g/日)および野菜・果物摂取量(g/日)に対応した10年以内の循環器疾患死亡確率を計算した。喫煙を調整し、男女別に計算した。食塩摂取量と野菜・果物摂取量に対応した死亡確率を表示するチャートを作成した。

結果　1980年から2004年までの24年間に、循環器疾患死亡者は918人観測され（男性451人、女性467人）、1000人年対4.73（男性5.46、女性4.18）であった。考慮された要因である年齢、喫煙の有無、食塩摂取量、野菜・果物摂取量の循環器疾患死亡に対する回帰係数をCox比例ハザードモデルに基づいて推定した。表1にその回帰係数、集団での各要因の平均値、およびこれに対応する10年目における生存率を、男女別に

示した。要因として Body mass index を含めた場合も結果は変わらなかった。これらを用いて、食塩摂取量と野菜・果物摂取量の各５階級（食塩；男性で 8, 11, 15, 18, 21(g/日), 女性で 6, 9, 12, 15, 18 (g/日), 野菜・果物摂取量; 男女ともに 200, 300, 400, 500, 600(g/日)）についての 10 年以内の循環器疾患死亡確率を、年齢４階級（40 歳代、50 歳代、60 歳代、70 歳以上）について計算し、これを色分けしたチャートで示した（図１）。男女ともに、各年齢層で、食塩摂取量が多いほど、野菜・果物摂取量が少ないほど、10 年後循環器疾患死亡率が上昇することが示された。

考察・まとめ　NIPPON DATA80･国民栄養調査結果統合データセットを解析に用いることで、高塩分の食事は循環器疾患死亡に対して危険因子としてはたらき、野菜・果物摂取量が多い食事は、予防的にはたらくことを視覚的に示すことができた。本研究では、1980 年 11 月の３日間の世帯分の食事調査結果を、世帯員の性・年齢を考慮して個人分に按分した推定摂取量を使用している。また、調査対象となった期間の食事が対象者にとって代表的な食事でなかった可能性や、調査以降にさまざまな要因により食事習慣が変化した可能性がある。そのため、本研究で示された食塩および野菜・果物摂取量と循環器疾患死亡の関連は弱められている可能性がある。そのうえで、それぞれの食事因子の影響が危険因子として、あるいは予防的に示されたことは、わが国における、元気で長生きするための食事のあり方を提示するうえで、きわめて価値が高いものと考えられた。

参考文献

・上島弘嗣, 岡山明, 澤井廣量, 他. 厚生省循環器疾患基礎調査の追跡調査の成果とその意義　－NIPPON DATA80 および 90－. 厚生の指標,　1999; 46(7): 17-20

・笠置文善、児玉和紀、上島弘嗣、片山博昭: NIPPON DATA80 を用いた健康評価チャート作成：脳卒中および冠動脈疾患. 日循予防誌 2005; 40(1):22-26,

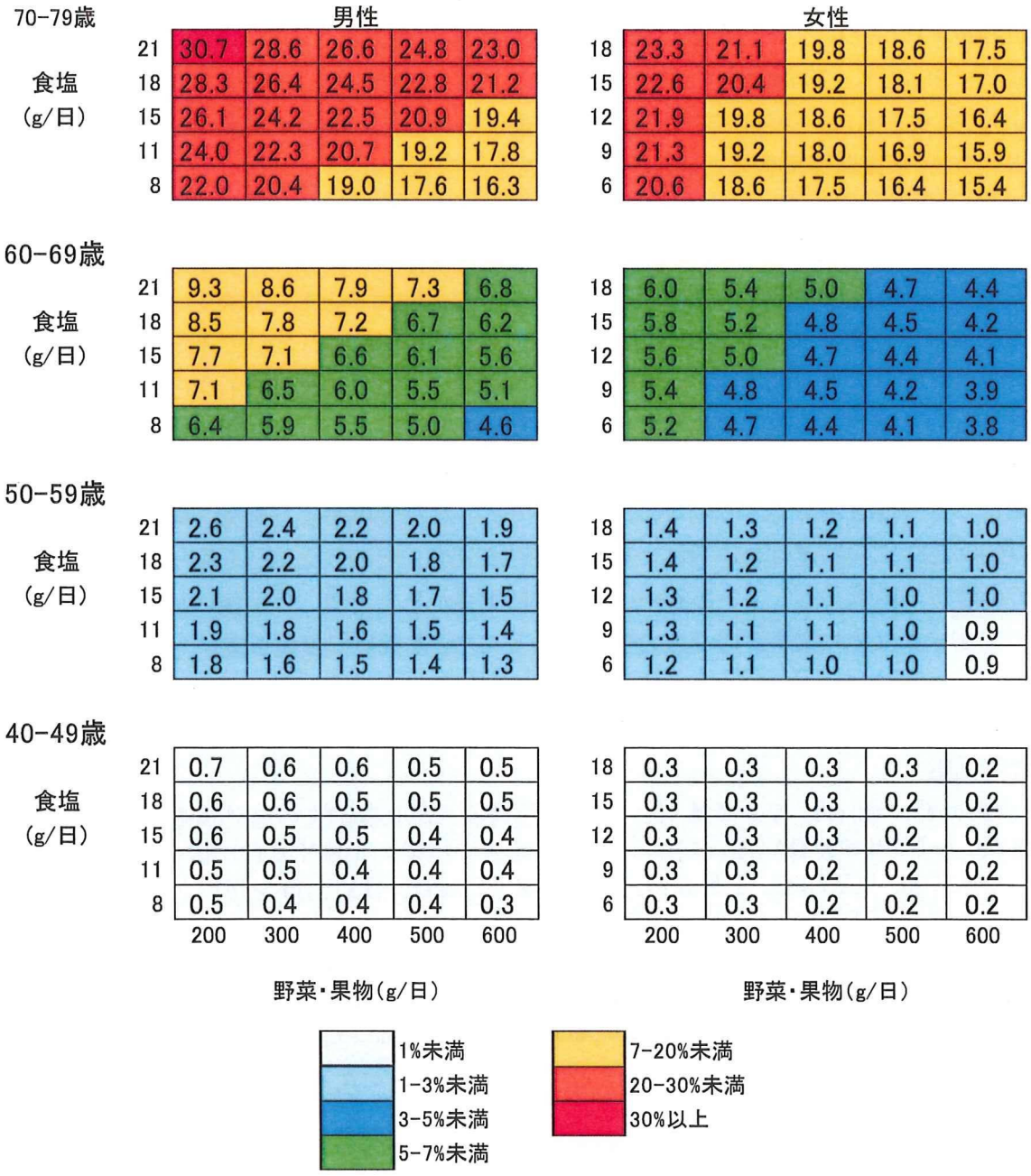
・Okuda N, Miura K, Yoshita K, Matsumura Y, Okayama A, Nakamura Y, et al. Integration of data from NIPPON DATA80/90 and National Nutrition Survey in Japan: for cohort studies of representative Japanese on nutrition. *J Epidemiol* 2010 (in press).

表1　循環器疾患死亡に対する要因の平均値と回帰係数(NIPPON DATA80 29年追跡)

要因	男性			女性		
	平均値	回帰係数	*P*	平均値	回帰係数	*P*
年齢(歳)	50.5	0.132	<0.001	50.9	0.147	<0.001
食塩摂取量(1g/日増加あたり)	15.2	0.027	0.004	13.1	0.024	0.025
野菜･果物摂取量(100g/日)	4.39	−0.095	0.003	4.65	−0.038	0.179
喫煙の有無(有=1, 無=0)	0.632	0.267	0.007	0.088	0.321	0.023
平均値に対する10年時点での生存率*		0.9900			0.9939	

*対象集団におえkる要因の平均値を持つ人の追跡10年時点での生存率

図1　食塩摂取量と野菜・果物摂取量を用いた10年以内の循環器疾患死亡確率(%)



中壮年期の血圧値および喫煙習慣によるADL低下リスク評価チャート

研究協力者　高嶋　直敬　(滋賀医科大学社会医学講座公衆衛生学部門　特任助教)
研究分担者　三浦　克之　(滋賀医科大学社会医学講座公衆衛生学部門　教授)
研究分担者　奥田　奈賀子　(滋賀医科大学社会医学講座公衆衛生学部門　特任助教)
研究分担者　笠置　文善　(財団法人放射線影響研究所疫学部　副部長)
研究分担者　児玉　和紀　(財団法人放射線影響研究所　主席研究員)
研究分担者　寶澤　篤　(東北大学大学院社会医学講座公衆衛生学分野　助教)
研究協力者　村上　義孝　(滋賀医科大学社会医学講座医療統計学部門　准教授)
研究代表者　上島　弘嗣　(滋賀医科大学生活習慣病予防センター　特任教授)

目的

日本をはじめ東アジア諸国では急速に高齢化が進んできている。今後、急速に高齢者が増える中でADL低下の予防が重要となってくる。高齢期のADL低下に関係している中壮年期の食生活習慣を明らかにし、さらにそれを視覚的に示すことが公衆衛生学的には極めて重要である。これまでに中壮年期の血圧や喫煙習慣などが将来のADL低下の要因となることをわれわれは報告してきた。そこで、われわれは日本人を代表する集団を追跡したコホート研究であるNIPPON DATA80の19年目のADL追跡データを用いてADL低下確率を計算した。

方法

1980年に全国から無作為に選ばれた300地区の中壮年期(47歳から61歳)の住民のうち、脳心血管疾患の既往歴がなく、1999年のADL追跡調査に参加した1839名を対象に解析した。ロジステック回帰モデルを用いてADL低下とベースライン時の要因との関連について解析を行い、それをもとにして19年目のADL低下確率を計算した。調整は総コレステロール、アルブミン、性別、年齢について調整した。収縮期血圧及び喫煙習慣に対応したADL低下確率を予測するチャートを作成した。

結果

1999年にADL低下者は男性30名、女性で42名であった。年齢、収縮期血圧、喫煙習慣、性別、総コレステロール、アルブミンを含むロジステック回帰モデルを用いてADL低下のリスクを推定した。回帰係数および平均値について表1に示した。

これを用いて図1に19年目のADLについて男女別、年齢を5歳階級(50,55,60歳)、収縮期血圧を20mmHgごと(100、120、140、160、180mmHg)での低下確率を算出した。

考察

NIPPON DATA80 を用いて、血圧や喫煙習慣が 19 年目の ADL 低下に与える影響について視覚的に示すことができた。この結果からは非喫煙者と比較して喫煙者で、男性と比較して女性のほうが、血圧低値と比較して高値で ADL 低下確率は高い傾向を示した。このことは中壮年期の血圧や喫煙など複合的に将来の ADL 低下に大きな影響を与えることを示した。さらに血圧の低下させる食事生活習慣や禁煙などが ADL 低下の予防のためにも重要であることが示唆された。

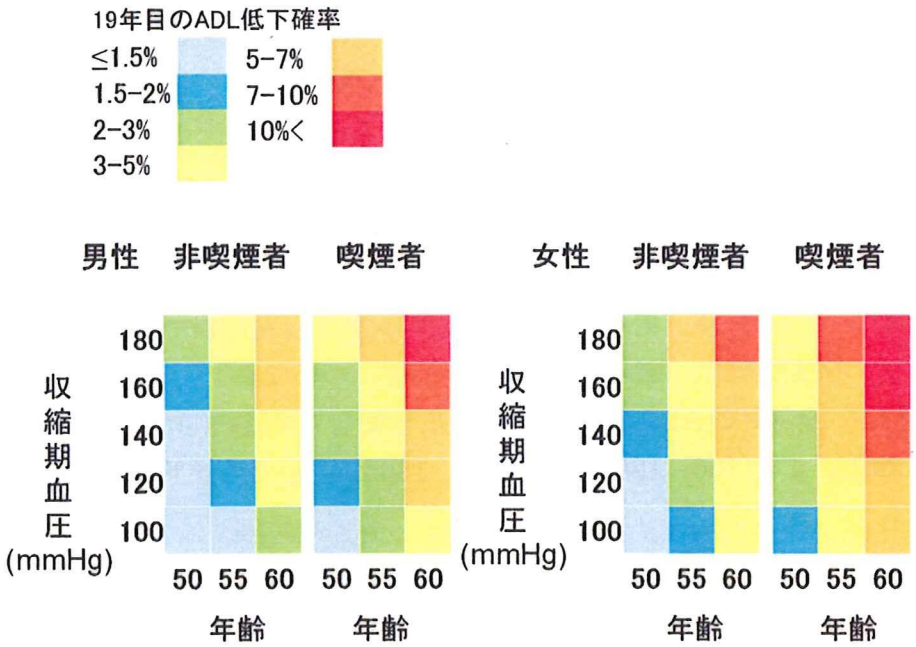
文献

笠置文善、児玉和紀、上島弘嗣、片山博昭: NIPPON DATA80 を用いた健康評価チャート作成：脳卒中および冠動脈疾患. 日循予防誌 2005; 40(1):22-26,

表 1　19 年目の ADL 低下に対する各要因の平均値と回帰係数(NIPPON DATA80)

	平均値	回帰係数	*P 値*
アルブミン値 (g/dl)	4.39	−0.0445	0.94
総コレステロール値 (mg/dl)	193.51	−0.00603	0.13
年齢 (歳)	52.88	0.1136	0.001
収縮期血圧 (mmHg)	138.48	0.0127	0.02
性別		0.3178	0.33
喫煙習慣		0.4908	0.14

図 1　中壮年期の血圧、喫煙習慣による 19 年目の ADL 低下確率(%)評価チャート



中年期の血圧高値と将来のADL低下についての検討—NIPPON DATA80—

研究協力者　寳澤 篤　　東北大学大学院社会医学講座公衆衛生学分野　助教
研究分担者　岡村 智教　　国立循環器病センター予防検診部　部長
研究協力者　村上 義孝　　滋賀医科大学社会医学講座医療統計学部門　准教授
研究協力者　門脇 崇　　滋賀医科大学社会医学講座公衆衛生学部門　助教
研究協力者　奥田 奈賀子　滋賀医科大学社会医学講座公衆衛生学部門　特任助教
研究協力者　高嶋 直敬　　滋賀医科大学社会医学講座公衆衛生学部門　特任助教
研究分担者　早川 岳人　　福島県立医科大学衛生学・予防医学講座　准教授
研究分担者　喜多 義邦　　滋賀医科大学社会医学講座公衆衛生学部門　講師
研究分担者　三浦 克之　　滋賀医科大学社会医学講座公衆衛生学部門　教授
研究分担者　中村 保幸　　京都女子大学家政学部生活福祉学科　教授
研究分担者　岡山 明　　財団法人結核予防会第一健康相談所　所長
研究代表者　上島　弘嗣　　滋賀医科大学生活習慣病予防センター　特任教授

背景

高血圧が日常生活動作（Activities of daily living, ADL）低下に影響を与えるとする研究がいくつか報告されているが、若年期における高血圧がその後のADL低下に関連するという報告は少ない。また、血圧がADL低下に及ぼすインパクトについての報告は筆者らの知る限り皆無であった。

方法

1999年における1980年の循環器疾患基礎調査受検者に対するADL調査にて、ADLが低下していた者と低下していなかった者を比較検討した。

今回の検討では1980年当時47-59歳であった者1891名を分析した。多重調整ロジスティック回帰分析を用いてADL低下のオッズ比を算出した。1980年当時の血圧カテゴリーは米国合同員会第7次報告（Joint National Committee 7 guidelines）に基づいて、ステージ2高血圧（収縮期血圧160mmHg以上または拡張期血圧100mmHg以上または降圧薬内服）、ステージ1高血圧（収縮期血圧140mmHg以上または拡張期血圧90mmHg以上）、前高血圧（収縮期血圧120mmHg以上または拡張期血圧80mmHg以上）、正常血圧（収縮期血圧120mmHg未満かつ拡張期血圧80mmHg未満）と定義した。

結果

1891名中75名がADL低下を報告した。正常血圧群と比較した前高血圧、ステージ1高血圧、ステージ2高血圧のADL低下のオッズ比(95%信頼区間)はそれぞれ1.50 (0.55-4.09), 1.56 (0.56-4.32), 2.96 (1.09-8.05)であった。これらのオッズ比から仮に対象者全員が当時正常血圧であった場合、どの程度のADL低下が回避できたかを推定したところ、33.7人(ADL低下者の45%)が回避可能であったと算出された。また死亡とADL低下を複合エン

ドポイントにした結果も算出した。正常血圧群と比較した健康寿命を達成できないリスク（死亡あるいはADL低下）のオッズ比（95%信頼区間）は前高血圧、ステージ1高血圧、ステージ2高血圧でそれぞれ1.22（0.83-1.78），1.13（0.76-1.69），1.78（1.20-2.66)であった。

結論

若年時の血圧高値は将来のADL低下を予測することが明らかとなった。血圧上昇を防ぐための生活習慣改善指導等が将来のADL低下者減少に貢献する可能性が示された。

Journal of Human Hypertension (2009) 23, 546–552

www.nature.com/jhh

ORIGINAL ARTICLE

High blood pressure in middle age is associated with a future decline in activities of daily living. NIPPON DATA80

A Hozawa[1], T Okamura[2], Y Murakami[3], T Kadowaki[3], N Okuda[3], N Takashima[3], T Hayakawa[4], Y Kita[3], K Miura[3], Y Nakamura[5], A Okayama[6] and H Ueshima[3], for the NIPPON DATA80 Research Group[7]

[1]*Division of Epidemiology, Department of Public Health and Forensic Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan;* [2]*Department of Preventive Cardiology, National Cardiovascular Center, Osaka, Japan;* [3]*Department of Health Science, Shiga University of Medical Science, Otsu, Japan;* [4]*Department of Hygiene and Preventive Medicine, Fukushima Medical University, Fukushima, Japan;* [5]*The Cardiovascular Epidemiology, Kyoto Women's University, Kyoto, Japan and* [6]*The First Institute for Health Promotion and Health Care, Japan Anti-Tuberculosis Association, Tokyo, Japan*

Although several studies have reported on the relation between high blood pressure (BP) and impaired activities of daily living (ADL), only a few studies have reported on the relation of high BP in middle-aged subjects with future impaired ADL. Furthermore, no studies reported an excess impaired ADL due to non-normal BP. Using ADL 1999 data, we compared data from NIPPON DATA80 survivors without impaired ADL ($N=1816$) with those with impaired ADL ($N=75$) using baseline BP information collected in 1980. We analysed participants who were aged 47–59 years at baseline. Multiple adjusted logistic regression analyses were used to estimate the risk of impaired ADL, according to baseline BP categories using Joint National Committee 7 guidelines (normal BP, prehypertension, stage 1 hypertension (HT) and stage 2 HT). Subjects who used antihypertensive medications were classified as having stage 2 HT. We calculated excess impaired ADL due to non-normal BP. Compared with normal BP categories, the adjusted odds ratio (OR) and 95% confidence interval (CI) of having impaired ADL was higher in subjects with prehypertension (OR = 1.50, 95% CI: 0.55–4.09), stage 1 HT (OR = 1.56, 95% CI: 0.56–4.32) and stage 2 HT (OR = 2.96, 95% CI: 1.09–8.05). Non-normal BP explained 45% (33.7/75) of impaired ADL. A positive relation of BP categories with the composite end point of mortality and impaired ADL was also observed. In conclusion, controlling BP in middle age may prevent deaths and future ADL decline.

Journal of Human Hypertension (2009) **23**, 546–552; doi:10.1038/jhh.2008.155; published online 18 December 2008

Keywords: blood pressure; activities of daily living; mortality; population attributable fraction

Introduction

Hypertension (HT) is one of the strongest risk factors for cardiovascular disease mortality and all-cause mortality.[1–3] Thus, control of blood pressure (BP) can increase lifespan. As the proportion of elderly people increases, the importance of preventing physical dysfunction, that is, impaired ability to perform activities of daily living (ADL), becomes a major public health concern for older people.[4]

We previously reported that the main cause of impaired ADL in Japan was stroke.[4] Other studies have shown that participants who died from stroke had a longer period of disability before death compared with participants who died of other causes.[5] It is well known that HT is a strong risk factor for stroke.[1–3] Therefore, HT may also be strongly associated with impaired ADL. However, only a few studies have reported the relation of HT with physical dysfunction or impaired ADL.[6–12] Furthermore, these studies primarily included elderly participants.[6–9] Only a few studies have examined the relation of BP measured at middle age and future disability,[11,12] and no studies have reported on the contribution of BP to impaired ADL. Furthermore, if we combined impaired ADL and deaths together, we can calculate the relation of BP with being alive without impaired ADL.

Correspondence: Dr A Hozawa, Division of Epidemiology, Department of Public Health and Forensic Medicine, Tohoku University Graduate School of Medicine, 2-1 Seiryo-machi, Aobaku, Sendai 980-8575, Japan.
E-mail: hozawa-thk@umin.ac.jp
[7]Members of the NIPPON DATA80 Research Group are listed in the Appendix.
Received 21 August 2008; revised 4 November 2008; accepted 14 November 2008; published online 18 December 2008

The objective of this study was to investigate the relation between the ability to perform ADL in 1999 and baseline BP measured in 1980 among a general population of Japanese subjects aged 47–59 years taken from NIPPON DATA80. NIPPON DATA80 is a cohort study that consisted of a representative Japanese sample surveyed in 1980.

Methods

Participants and follow-up

Two cohort studies of the National Survey on Circulatory Disorders comprise the National Integrated Project for Prospective Observation of Noncommunicable Disease and Its Trends in the Aged (NIPPON DATA). Baseline surveys were performed in 1980 (NIPPON DATA80)[13–18] and in 1990.[19–21] Detailed methods of NIPPON DATA have been described previously.[13,17,19] We analysed the 19-year follow-up data from NIPPON DATA80 in this study.

Baseline surveys were carried out at local public health centres, and all participants had to be capable of reaching the examination centre without assistance.

Biochemical and physical examinations

Baseline BP was measured by trained observers using a standard mercury sphygmomanometer on the right arm of seated participants after at least 5 min of rest. We defined BP categories as follows: stage 2 HT, systolic BP $\geqslant$160 mm Hg and/or diastolic BP $\geqslant$100 mm Hg; stage 1 HT, systolic BP 140–159 mm Hg and/or diastolic BP 90–99 mm Hg; prehypertension, systolic BP 120–139 mm Hg and/or diastolic BP 80–89 mm Hg; normal BP, systolic BP $<$120 mm Hg and diastolic BP $<$80 mm Hg. If participants were taking antihypertensive medication, they were categorized into stage 2 HT irrespective of their BP level. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Public health nurses obtained data including smoking habits, as well as current health status and medical history. Non-fasting blood samples were separated by centrifugation within 60 min of collection in 1980 and stored at −70 °C. Blood glucose levels were measured using the cupric-neocuproine method, and the values were adjusted by using the formula ((0.047 × (glucose concentration in mg per 100 ml))−0.541) to obtain the approximate value measured by the hexokinase method, which gives levels in mmol l^{-1}.[18] Diabetes was defined as casual blood glucose level of 11.1 mmol l^{-1} or self-reported diabetes.[18] Serum albumin and total cholesterol levels were measured by a sequential autoanalyzer (SMA12/60; Technicon, Tarrytown, NY, USA) using bromocresol-green staining for albumin and the Lieberman-Burchard direct method for total cholesterol at a specific laboratory (presently the Osaka Medical Center for Health Science and Promotion).

ADL survey

The NIPPON DATA studies performed follow-up ADL surveys in 1994[4] and 1999. In this study, we analysed 1999 data because we wanted to examine the effect of high BP in middle-aged subjects on future ADL decline. The 1999 ADL survey was done in subjects aged $\geqslant$65 years at that time. Participants aged 45 years and younger were not surveyed and some of the participants aged 46 years were not surveyed. Furthermore, because we wanted to study the effect of high BP in middle-aged subjects, we limited the upper age of subjects in this study to those younger than 60 years at baseline.

We asked 300 Public Health Centers to participate in the 1999 ADL survey, and 249 of them agreed. In these areas, 2724 participants were between the ages of 47 and 59 years at baseline. Among them, 75 participants were excluded because of a history of cardiovascular disease (that is, acute myocardial infarction (AMI) or stroke), and because of lack of information on serum total cholesterol levels, blood glucose levels, height, weight and serum albumin levels. The remaining 2649 participants were surveyed; however, 385 died and 84 moved before the ADL survey. Thus, 2180 participants were asked to respond to the ADL survey and 1891 did so (87%) (Figure 1). No significant differences were seen between responders and non-responders for baseline age, BP values, use of antihypertensive medications, BMI, smoking status and albumin levels (Table 1). Non-responders had a significantly higher total cholesterol level than responders ($P<0.01$).

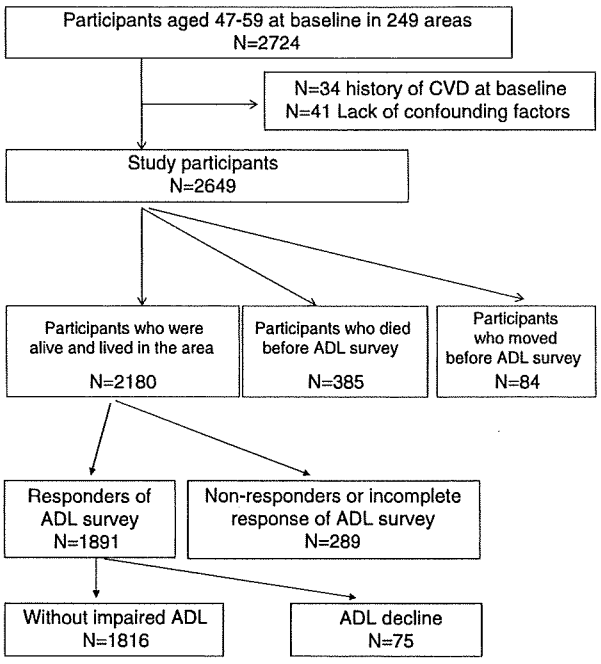


Figure 1 Flow chart of the study participants. N, number of participants; ADL, activities of daily living.

Table 1 Difference between responder of survey for activity of daily living and non-responder

	Responder	*Non-responder*	*P-value*
	1891	289	
Age (years)	52.9 (3.6)	52.7 (3.8)	0.33
Sex (female)	59%	64%	0.09
Systolic blood pressure (mm Hg)	138.4 (19.8)	136.5 (19.9)	0.14
Diastolic blood pressure (mm Hg)	83.3 (11.9)	82.1 (11.6)	0.11
Antihypertensive medication (yes)	10%	8%	0.31
Body mass index ($kg\,m^{-1}$)	23.0 (3.1)	23.1 (3.1)	0.89
Current smoking	30%	29%	0.63
Daily drinker	22%	20%	0.41
Total cholesterol ($mmol\,l^{-1}$)	5.00 (0.85)	5.18 (0.90)	<0.01
Albumin ($g\,l^{-1}$)	43.9 (2.3)	44.0 (2.3)	0.43

Values are expressed as means (s.d.) or %.
P-values were tested by *t*-test or χ^2-test.

Participants were asked about five basic ADL items (feeding, dressing, bathing, toileting and transfer (walking indoors)), as modified from Katz *et al.*[22] and whether each of these items could be accomplished without help, with partial help or with full help. Participants were also asked whether they had a history of stroke, lower limb fracture and AMI.[4] This survey was conducted through telephone interviews (10.5%), face-to-face interviews at home (80.0%) and other methods (9.5%). Impaired ADLs were defined as partial or full support needed to perform any of the five basic ADL items. As previously reported,[13,17,19] we identified participants who had died by computer matching data from Japanese National Vital Statistics records, using area, gender, birth date and death as key codes. We obtained permission to use the National Vital Statistics records from the Management and Coordination Agency of the Government of Japan. The Institutional Review Board of Shiga University of Medical Science (no.12–18, 2000) approved the study.

Statistical analysis

Analysis of variance for continuous variables or χ^2-test for proportions were used to compare baseline characteristics. The relationship between BP categories and impaired ADL was calculated using multiple adjusted logistic regression models. The multivariable-adjusted odds ratio (OR) for impaired ADL was adjusted for age, sex, BMI (<18.5, 18.5–24.9, $\geqslant 25\,kg\,m^{-2}$), cigarette smoking (current, ex-smoker, never smoked), drinking (everyday, sometimes, ex-drinker, never), diabetes, total cholesterol levels and albumin levels. We also added a history of stroke and AMI at the ADL survey as covariates in an additional model to determine the role of stroke or AMI on the relation between high BP and impaired ADL. The normal BP group was used as the reference group. The OR for having impaired ADL was calculated using multiple logistic regression analysis. To identify the effect of BP on being alive without impaired ADL, we also analysed the OR for the composite outcome of impaired ADL and death before the ADL survey ($N=385$) using multiple logistic regression analysis. Trend tests were performed by allocating scores 1, 2, 3 and 4 to all participants with normal BP, prehypertension, stage 1 HT and stage 2 HT, respectively.

The percentage of excess impaired ADL due to non-normal BP was calculated as follows: $P \times (OR - 1)/OR$, where P = proportion of cases exposed to the risk factor.[23] All probability values were two-tailed and all confidence interval (CIs) were estimated at the 95% level. SAS software (version 9.1, SAS Institute, Cary, NC, USA) was used for analyses.

Results

Table 2 shows the baseline characteristics of the 1891 study participants. According to the BP categories, participants in the higher BP categories were older, and had a higher BMI, albumin level, and total cholesterol level than those in the lower BP categories. The proportion of women was higher in the lower BP categories.

Table 3 shows the relation of baseline BP categories to impaired ADL. The age- and sex-adjusted OR of having impaired ADL was higher in the higher BP categories. The age- and sex-adjusted OR (CIs) of prehypertension, stage 1 HT and stage 2 HT were 1.38 (0.51–3.71), 1.49 (0.55–4.06) and 2.92 (1.11–7.67), respectively. This trend was unchanged when we adjusted for BMI, smoking status, drinking status, diabetes, total cholesterol levels and albumin levels. No sex differences were observed for the relation of BP categories and impaired ADL (P for interaction = 0.38).

When we further adjusted for the history of stroke at the end of follow-up, the relation between high BP and impaired ADL was largely attenuated. The adjusted ORs for prehypertension, stage 1 HT and stage 2 HT were 1.59 (0.56–4.53), 1.75 (0.60–5.12) and 2.10 (0.73–6.05), respectively. This suggests that stroke plays an important causal role in the relation between high BP and impaired ADL. On the other

Table 2 Baseline characteristics according to BP categories, NIPPON DATA80 1980

	Normal BP	*Prehypertension*	*Stage 1 HT*	*Stage 2 HT*	P-*value*
N	230	682	541	438	
Age (years)	52.3 (3.7)	52.6 (3.6)	52.6 (3.6)	53.4 (3.6)	<0.01
Sex (female)	63%	62%	55%	57%	0.03
Systolic BP (mm Hg)	110.3 (6.3)	127.5 (6.5)	144.7 (7.3)	162.2 (18.0)	<0.01
Diastolic BP (mm Hg)	68.2 (6.0)	77.8 (6.5)	86.5 (7.2)	95.9 (11.1)	<0.01
Antihypertensive medication (yes)	0%	0%	0%	44%	<0.01
Body mass index ($kg\,m^{-2}$)	21.8 (3.0)	22.5 (3.0)	23.3 (3.0)	24.1 (3.2)	<0.01
Current smoking	35%	28%	33%	28%	0.10
Daily drinker	17%	17%	27%	27%	<0.01
Diabetes	4%	3%	4%	4%	0.44
Total cholesterol ($mmol\,l^{-1}$)	43.1 (2.2)	43.7 (2.3)	44.0 (2.4)	44.3 (2.3)	<0.01
Albumin ($g\,l^{-1}$)	4.8 (0.9)	5.0 (0.8)	5.1 (0.9)	5.1 (0.9)	<0.01

Abbreviations: BP, blood pressure; HT, hypertension; *N*, number of participants.
Values are expressed as means (s.d.) or %.
Stage 2 HT: systolic BP ⩾160 mm Hg and/or diastolic BP⩾100 mm Hg.
Stage 1 HT: not satisfied with stage 2 HT and systolic BP 140–159 mm Hg and/or diastolic BP 90–99 mm Hg.
Prehypertension: satisfied with neither stage 2 nor stage 1 HT criteria and systolic BP 120–139 mm Hg and/or diastolic BP 80–89 mm Hg.
Normal BP: systolic BP <120 mm Hg and diastolic BP <80 mm Hg.
User of antihypertensive medications were included in stage 2 HT categories.
P-values were tested by *t*-test or χ^2-test.

Table 3 Relation of baseline BP category with impaired ADL assessed at 19 years after baseline among participants aged 47–59 years at baseline

BP category at baseline[a]	*Normal BP*	*Prehypertension*	*Stage 1 HT*	*Stage 2 HT*	P *for trend*
Participants alive at the end of follow-up without impaired ADL	255	661	522	408	
Participants alive with impaired ADL	5	21	19	30	
Age-, sex-adjusted OR (95% CI)	1	1.38 (0.51–3.71)	1.49 (0.55–4.06)	2.92 (1.11–7.67)	<0.01
Multivariate adjusted OR (95% CI)[b]	1	1.50 (0.55–4.09)	1.56 (0.56–4.32)	2.96 (1.09–8.05)	<0.01
Excess impaired ADL due to non-normal BP	0	7.0	6.8	19.9	
Population attributable fraction		9.3%	9.0%	26.5%	

Abbreviations: ADL, activity of daily living; BP, blood pressure; CI, confidence interval; OR, odds ratio.
NIPPON DATA80, 1980–1999.
[a]Definition of BP categories are described in Table 2.
[b]Adjusted for age, sex, body mass index (<18.5, 18.5–24.9, 25 $kg\,m^{-2}$), and smoking (current, ex-smoker), drinking (daily, occasional, ex-drinker), diabetes, total cholesterol and albumin.

hand, adjustment for history of AMI at the end of follow-up did not change the findings (data not shown).

From the adjusted OR, we calculated the proportion of impaired ADL due to non-normal BP, and 7.0, 6.8 and 19.9 of excess impaired ADL were due to prehypertension, stage 1 HT and stage 2 HT, respectively. Thus, among 75 survivors with impaired ADL, non-normal BP, that is, prehypertension, stage 1 HT and stage 2 HT, explained 33.7 (44.9%) of impaired ADL.

To assess the relation between BP and being alive without impaired ADL, we calculated the risk of baseline BP categories using the composite end point of impaired ADL and all-cause death. Of 385 participants who died before the ADL survey, 191 (50%), 46 (12%), 50 (13%), 7 (2%) and 91 (24%) died of cancer, stroke, heart disease, other cardiovascular disease and other causes, respectively. The ORs of the composite end points were 1.22 (0.83–1.78), 1.13 (0.76–1.69) and 1.78 (1.20–2.66) for prehypertension, stage 1 HT and stage 2 HT, respectively (Table 4).

Discussion

This study revealed a positive correlation between high BP at middle age and impaired ADL in the future, as well as the composite end point of impaired ADL and death. We found that 45% of impaired ADL could be explained by non-normal BP in Japanese subjects. This suggests that, among Japanese subjects, non-normal BP in middle age is an important determinant of future impaired ADL.

There are several prospective studies reporting the relation of BP to physical performance.[6–12] However, most of these studies investigated elderly populations.[6–9] Studies focusing on the relation between BP measured at middle age and future

Table 4 Relation of baseline blood pressure (BP) category with composite outcome (impaired ADL and all-cause mortality) assessed at 19 years after baseline among participants aged 47–59 years at baseline

BP category at baseline[a]	*Normal BP*	*Prehypertension*	*Stage 1 HT*	*Stage 2 HT*	P *for trend*
Overall *N*	271	809	641	555	
Number of composite outcome[b]	46	148	119	147	
Age-, sex-adjusted OR (95% CI)	1	1.10 (0.76–1.60)	1.00 (0.68–1.47)	1.57 (1.07–2.29)	<0.01
Multivariate adjusted OR (95% CI)[c]	1	1.23 (0.84–1.81)	1.14 (0.77–1.70)	1.79 (1.20–2.67)	<0.01

Abbreviations: ADL, activity of daily living; BP, blood pressure; CI, confidence interval; OR, odds ratio.
NIPPON DATA80, 1980–1999.
[a]Definition of BP categories are described in Table 2.
[b]Deceased participants and participants alive with impaired ADL at the end of follow-up.
[c]Adjusted for age, sex, body mass index (<18.5, 18.5–24.9, 25 $kg\,m^{-2}$), smoking (current, ex-smoker), drinking (daily, occasional, ex-drinker), diabetes, total cholesterol and albumin.

disability are scarce.[11,12] Although Pinsky *et al.*[10] investigated 2021 participants whose baseline age range was 28–62 years and found long-term HT related to disability, they used 'ever hypertensive,' that is, whether participants were diagnosed with HT during follow-up, as a risk factor. Thus, their study could not conclude whether BP measured at middle age could predict future disability. Reed *et al.*[11] investigated physical function among 3263 subjects with Japanese ancestry who had information from 28 years before the survey. The baseline age of these participants ranged from 45 to 68 years. They found that the most consistent predictor of healthy aging was low BP. Guralnik *et al.*[12] also studied participants of the Alameda County Study who were aged 46–70 years at baseline and investigated the relation of high BP with physical function after 19 years.[12] They found that high BP predicted future lower levels of physical function. These latter two findings were mostly consistent with our results showing that high BP at ages 47–59 predicts impaired ADL after 19 years.

It is well known that high BP is associated with a higher risk of stroke.[1–3] We previously reported the prevalence of impaired ADL and the magnitude of the association with stroke.[4] Similarly, another study in Japan showed that the duration of disability before death was longer in participants who died of stroke than in participants who died of other reasons.[5] In that study, 45% of patients who died from stroke had more than 6 months of disability.[5] These findings are consistent with our results, that is, BP was strongly related with impaired ADL. Our results that adjustment for stroke history at the end of the follow-up largely attenuated the relation between high BP and impaired ADL also support the idea that stroke plays an important role in the relation between high BP and impaired ADL. Although Ohmori *et al.*[5] also showed that the risk of long-term disability was lower in participants who died from ischaemic heart diseases, which is strongly affected by BP, than in those who died from other causes, our study showed that, overall, higher BP levels at middle age were strongly associated with a future decline in ADL.

We found that 45% of impaired ADL was explained by non-normal BP in our study. This suggests that preventing progression of non-normal BP might yield a lower incidence of ADL decline. Because participants of NIPPON DATA80 included a representative Japanese general population, and the response rate of the ADL survey was high, we believe that these rates are applicable to a general Japanese population. However, this rate may not be applicable to other populations where mortality or incidence rates of stroke are lower. Further studies conducted in other countries that assess the impact of BP on impaired ADL would be of interest.

We also found that high BP was strongly associated with the composite end point of death and impaired ADL. This supports the idea that preventing high BP is important not only for preventing impaired ADL but also preventing death; that is, controlling or managing BP in middle-aged subjects may have the potential to prolong the duration of lives without impaired ADL, thus increasing so called healthy life expectancies.[24]

There are several limitations to this study. First, we did not assess baseline ADL conditions. Thus, we could not determine whether participants had been independent at baseline. However, because participants arrived at the baseline exam on foot and because we also excluded participants who had a history of stroke, we considered the effect of the lack of information on baseline ADL on our results to be negligible. Second, we assessed ADL only in 1999, and, some participants progressed to impaired ADL before the ADL survey. However, many participants with impaired ADL died before the ADL survey. Thus, we believe we adequately addressed this limitation by exploring the composite end point of death and impaired ADL. Finally, because we focused on the relation between BP at middle age (<60 years) and future ADL decline, the oldest participants in 1999 were younger than 80 years. In Japan, in 1980, life expectancy at 40 years was 35.5 years for men and 40.2 years for women.[25] Thus, our participants might be too young to assess the impact of BP at middle age on lifetime disability. However, we believe that our information is important to

assess the impact of high BP on premature impaired ADL and death.

In conclusion, non-normal BP in middle age is a strong predictor of impaired ADL 19 years later. Nearly half of the impaired ADL in 1999 was shown to be related to non-normal BP in 1980. Non-normal BP also predicted the composite outcome of death and impaired ADL; that is, lower BP in middle age can yield longer healthy life expectancies.

What is known about topic

- Although several studies have reported on the relation between high blood pressure (BP) and impaired activities of daily living (ADL), only a few studies have reported on the relation of high BP in middle age with future impaired ADL.
- No studies have reported an excess incidence of impaired ADL due to non-normal BP levels.

What this study adds

- BP categories measured at middle age could predict future impaired ADL and the composite end point of impaired ADL and death.
- We found that 45% of impaired ADL could be explained by non-normal BP in Japanese subjects.

Acknowledgements

We thank all members of the Japanese Association of Public Health Center Directors and all staff of the public health centres that cooperated with our study. This study was supported by a Grant-in-Aid from the Ministry of Health and Welfare under the auspices of the Japanese Association for Cerebro-cardiovascular Disease Control, a Research Grant for Cardiovascular Diseases (7A-2) from the Ministry of Health, Labour and Welfare and a Health and Labour Sciences Research Grant, Japan (Comprehensive Research on Aging and Health: H11-chouju-046, H14-chouju-003, H17-chouju-012 and H19-chouju-014).

Conflict of interest

There are no conflicts of interest.

References

1 Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL *et al.*, National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003; **289**: 2560–2572.

2 Mancia G, De Backer G, Dominiczak A, Cifkova R, Fagard R, Germano G, *et al.*, Management of Arterial Hypertension of the European Society of Hypertension; European Society of Cardiology. 2007 Guidelines for the Management of Arterial Hypertension: The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007; **25**: 1105–1187.

3 Japanese Society of Hypertension. Japanese Society of Hypertension guidelines for the management of hypertension (JSH 2004). *Hypertens Res* 2006; **29**(Suppl): S1–S105.

4 Hayakawa T, Okayama A, Ueshima H, Kita Y, Choudhury SR, Tamaki J, on the behalf of the NIPPON DATA80 Research Group. Prevalence of impaired activity of daily living and the impact of stroke and lower limb fracture in elderly persons in Japan. *CVD prevention* 2000; **3**: 187–194.

5 Ohmori K, Kuriyama S, Hozawa A, Ohkubo T, Tsubono Y, Tsuji I. Modifiable factors for the length of life with disability before death: mortality retrospective study in Japan. *Gerontology* 2005; **51**: 186–191.

6 Wang L, van Belle G, Kukull WB, Larson EB. Predictors of functional change: a longitudinal study of nondemented people aged 65 and older. *J Am Geriatr Soc* 2002; **50**: 1525–1534.

7 Kuo HK, Jones RN, Milberg WP, Tennstedt S, Talbot L, Morris JN *et al.* Effect of blood pressure and diabetes mellitus on cognitive and physical functions in older adults: a longitudinal analysis of the advanced cognitive training for independent and vital elderly cohort. *J Am Geriatr Soc* 2005; **53**: 1154–1161.

8 Nishinaga M, Takata J, Okumiya K, Matsubayashi K, Ozawa T, Doi Y *et al.* High morning home blood pressure is associated with a loss of functional independence in the community-dwelling elderly aged 75 years or older. *Hypertens Res* 2005; **28**: 657–663.

9 Roos NP, Havens B. Predictors of successful aging: a twelve-year study of Manitoba elderly. *Am J Public Health* 1991; **81**: 63–68.

10 Pinsky JL, Branch LG, Jette AM, Haynes SG, Feinleib M, Cornoni-Huntley JC *et al.* Framingham Disability Study: relationship of disability to cardiovascular risk factors among persons free of diagnosed cardiovascular disease. *Am J Epidemiol* 1985; **122**: 644–656.

11 Reed DM, Foley DJ, White LR, Heimovitz H, Burchfiel CM, Masaki K. Predictors of healthy aging in men with high life expectancies. *Am J Public Health* 1998; **88**: 1463–1468.

12 Guralnik JM, Kaplan GA. Predictors of healthy aging: prospective evidence from the Alameda County study. *Am J Public Health* 1989; **79**: 703–708.

13 Okamura T, Hayakawa T, Kadowaki T, Kita Y, Okayama A, Elliott P *et al.*, NIPPON DATA80 research group. A combination of serum low albumin and above-average cholesterol level was associated with excess mortality. *J Clin Epidemiol* 2004; **57**: 1188–1195.

14 Ueshima H, Choudhury SR, Okayama A, Hayakawa T, Kita Y, Kadowaki T *et al.* Cigarette smoking as a risk factor for stroke death in Japan: NIPPON DATA80. *Stroke* 2004; **35**: 1836–1841.

15 Okamura T, Hayakawa T, Kadowaki T, Kita Y, Okayama A, Elliott P *et al.*, NIPPONDATA80 Research Group. Resting heart rate and cause-specific death in a 16.5-year cohort study of the Japanese general population. *Am Heart J* 2004; **147**: 1024–1032.

16 Okamura T, Tanaka H, Miyamatsu N, Hayakawa T, Kadowaki T, Kita Y *et al.*, NIPPON DATA80 research group. The relationship between serum total cholesterol and all-cause or cause-specific mortality in a 17.3-year study of a Japanese cohort. *Atherosclerosis* 2007; **190**: 216–223.

17 Okamura T, Hayakawa T, Hozawa A, Kadowaki T, Murakami Y, Kita Y *et al.*, NIPPON DATA80 research group. Lower levels of serum albumin and total cholesterol were associated with decline in activities of daily living and excess mortality in a 12-year cohort study of elderly Japanese. *J Am Geriatr Soc* 2008; **56**: 529–535.
18 Kadowaki S, Okamura T, Hozawa A, Kadowaki T, Kadota A, Murakami Y *et al.*, NIPPON DATA Research Group. Relationship of elevated casual blood glucose level with coronary heart disease, cardiovascular disease and all-cause mortality in a representative sample of the Japanese population. NIPPON DATA80. 2008; **51**: 575–582.
19 Okamura T, Hayakawa T, Kadowaki T, Kita Y, Okayama A, Ueshima H, NIPPON DATA90 Research Group. The inverse relationship between serum high-density lipoprotein cholesterol level and all-cause mortality in a 9.6-year follow-up study in the Japanese general population. *Atherosclerosis* 2006; **184**: 143–150.
20 Hozawa A, Okamura T, Kadowaki T, Murakami Y, Nakamura K, Hayakawa T, *et al.*, NIPPON DATA90 Research Group. Gamma-Glutamyltransferase predicts cardiovascular death among Japanese women. *Atherosclerosis* 2007; **194**: 498–504.
21 Kadota A, Hozawa A, Okamura T, Kadowak T, Nakmaura K, Murakami Y *et al.*, NIPPON DATA Research Group. Relationship between metabolic risk factor clustering and cardiovascular mortality stratified by high blood glucose and obesity: NIPPON DATA90, 1990–2000. *Diabetes Care* 2007; **30**: 1533–1538.
22 Katz S, Downs TD, Cash HR, Grotz RC. Progress in development of the index of ADL. *Gerontologist* 1970; **10**: 20–30.
23 Rockhill B, Newman B, Weinberg C. Use and misuse of population attributable fractions. *Am J Public Health* 1998; **88**: 15–19.
24 World Health Organization. *World Health Report 2004: Changing History (World Health Report).* World Health Organization: Geneva, 2002.
25 Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare. *The 20th Life Tables.* Health and Welfare Statistics Association: Tokyo, 2007 (in Japanese).

Appendix

List of the NIPPON DATA80 Research Group.

NIPPON DATA: 'National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in the Aged.'

Chairman: Hirotsugu Ueshima (Department of Health Science, Shiga University of Medical Science, Otsu, Shiga).

Consultant: Osamu Iimura (Hokkaido JR Sapporo Hospital, Sapporo, Hokkaido), Teruo Omae (Health C&C Center, Hisayama, Kasuya, Fukuoka), Kazuo Ueda (Murakami Memorial Hospital, Nakatsu, Oita), Hiroshi Yanagawa (Saitama Prefectural University, Koshigaya, Saitama), Hiroshi Horibe (Aichi Medical University, Nagakute, Aichi).

Participating researchers: Akira Okayama (The First Institute of Health Service, Japan Anti-Tuberculosis Association, Chyioda-ku, Tokyo), Kazunori Kodama, Fumiyoshi Kasagi (Department of Epidemiology, Radiation Effects Research Foundation, Hiroshima, Hiroshima), Tomonori Okamura (Department of Preventive Cardiology, National Cardiovascular Center, Suita, Osaka), Yoshikuni Kita (Department of Health Science, Shiga University of Medical Science, Otsu, Shiga), Takehito Hayakawa (Department of Hygiene and Preventive Medicine, Fukushima Medical University, Fukushima, Fukushima), Shinichi Tanihara (Department of Hygiene and Preventive Medicine, Fukuoka University School of Medicine, Fukuoka, Fukuoka), Shigeyuki Saito (Second Department of Internal Medicine, Sapporo Medical University School of Medicine, Sapporo, Hokkaido), Kiyomi Sakata (Department of Hygiene and Preventive Medicine, Iwate Medical University School of Medicine, Morioka, Iwate), Yosikazu Nakamura (Department of Public Health, Jichi Medical University School of Medicine, Shimotsuke, Tochigi), Fumihiko Kakuno (Higashiomi Public Health Center, Higashiomi, Shiga).

Participating research associates: Toshihiro Takeuchi, Mitsuru Hasebe, Fumitsugu Kusano, Takahisa Kawamoto and members of 300 Public Health Centers in Japan, Masumi Minowa (Faculty of Humanities, Seitoku University, Matsudo, Chiba), Minoru Iida (Kansai University of Welfare Sciences, Kashiwara, Osaka), Tsutomu Hashimoto (Kinugasa General Hospital, Yokosuka, Kanagawa), Shigemichi Tanaka (Department of Cardiology, Cardiovascular Center, Teine Keijinkai, Sapporo, Hokkaido), Atsushi Terao (Health Promotion Division, Department of Public Health and Welfare, Shiga Prefecture, Otsu, Shiga), Katsuhiko Kawaminami (Department of Public Health Policy, National Institute of Public Health, Wako, Saitama), Koryo Sawai (The Japanese Association for Cerebro-cardiovascular Disease Control, Tokyo), Shigeo Shibata (Clinical Nutrition, Kagawa Nutrition University, Sakado, Saitama).