2種類以上存在し，その頻度が1％以上の頻度で存在することと定義される．身体運動に伴う脂質代謝の改善にも遺伝子多型の影響が報告されているが，ここでは脂質代謝に影響すると遺伝的素因としてアポリポ蛋白Ｅ(*Apo E*)遺伝子とLPL遺伝子に焦点を絞り身体トレーニングの効果に及ぼす影響に関して紹介する．*Apo E*遺伝子多型には，*E2*型，*E3*型，*E4*型が存在する．例えば，有酸素運動に伴いHDL-cは上昇し，TGは減少することが多いが，*E2*型ではHDL-cおよび，その亜分画であるHDL2-cの増加を認めるが，他の多型では増加しない．また，TGに関しては*E2*および*E3*型で減少するが，*E4*型では変化しない[20]．この点に関しては，1,000例を越す成人男性症例での横断的研究でも明らかとされている[21]．

また，LPL遺伝子多型は40種類以上報告されているが，身体トレーニングに関しては*Hins III*型と*Pvu II*型の影響が報告されている．その結果，*Pvu II*－/－型は*Pvu II*＋/－型に比べ有酸素運動に伴うHDL-cおよびHDL2-cの増加量が多いことが報告されている[22]．さらに，ある種の高脂血症発症の遺伝子多型を有する高リスク群であっても，高い身体活動群の脂質代謝水準は，遺伝素因を有しない群と比較し，有意差を認めないとの観察もある．この事実は，個人の脂質代謝異常には遺伝的素因のみで規定されるのではなく，身体運動といった後天的要因によっても変化しうることを意味している．

要　約

高脂血症の発症および改善に及ぼす身体運動(活動)の貢献に関する運動疫学の研究成果を要約し，身体運動はインスリン抵抗性症候群(＝metabolic fitness)の改善に有効に作用するとの証拠を示した．さらに，脂質代謝改善メカニズムに関して生理，生化学および遺伝学的な立場から解説し，身体活動を高めることの意義を強調した．

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生活習慣病・耐糖能異常者のための「健康観変容プログラム」

日々の生活のなかで血糖コントロールしなければならない糖尿病。食事や運動など、これまでの日常生活を改善し、それを続けなくてはなりません。そのためには個人の健康観の変容が重要になってきます。

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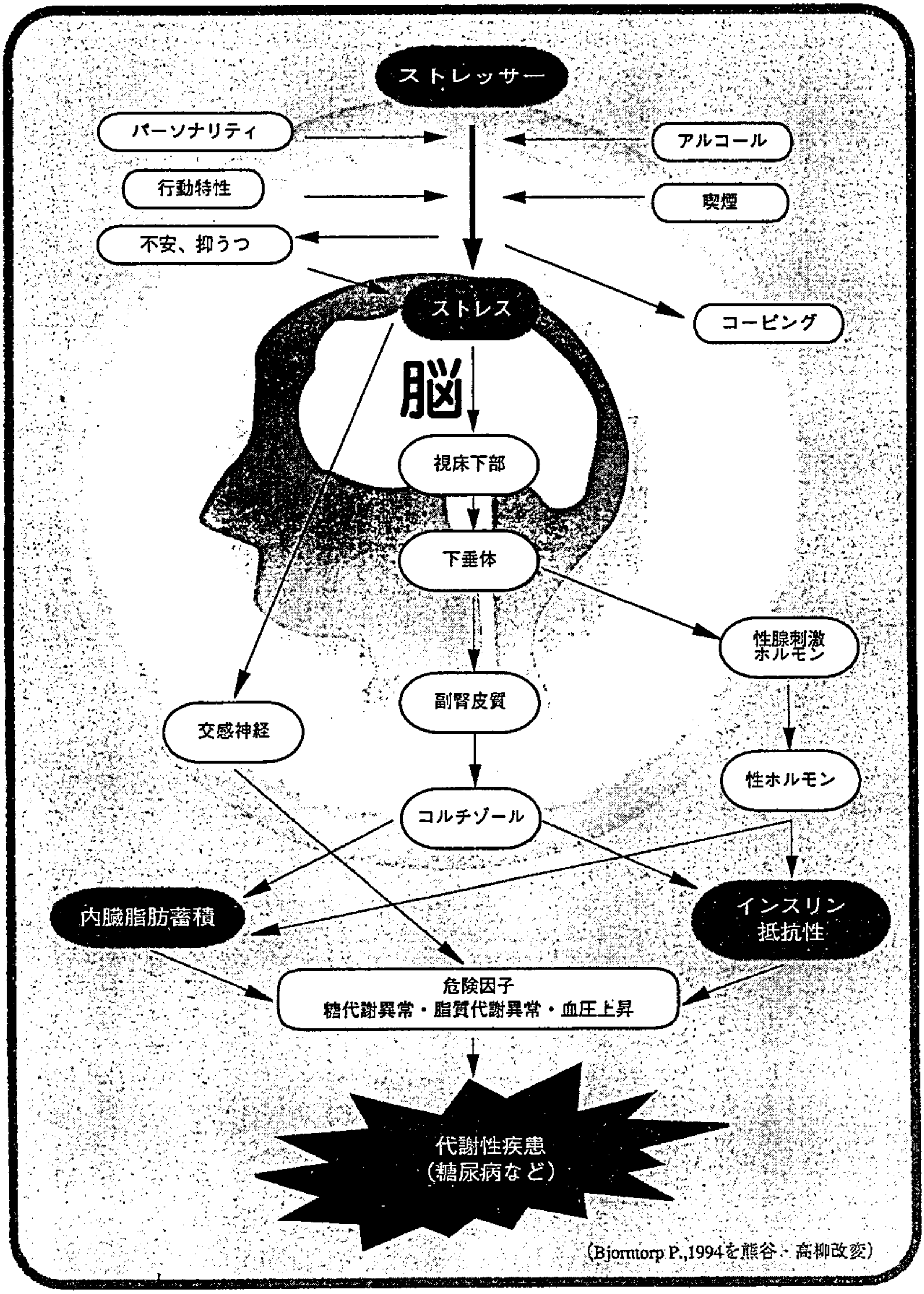
はじめに

糖尿病には、内臓脂肪蓄積型の肥満を伴う方が多くみられます。内臓脂肪蓄積型の肥満者には、糖がうまく利用できなかったり、脂質代謝の異常も認められます。その背景には、さまざまなストレス刺激（ストレッサー）が、内臓脂肪の蓄積やインスリン抵抗性という病態を生じさせるメカニズムが考えられています（図1）。

糖尿病等の生活習慣病はライフスタイルに関連した疾患概念ですが、その上流には種々のストレス刺激、ストレスコーピング（ストレスへの対処行動）、パーソナリティ等の統合の結果、個々人のライフスタイルが悪化し、それが生活習慣病発症の主たる要因であるという認識が必要です。また糖尿病は生涯、生活のなかでコントロールを続けることが大切です。私たちはそうした認識の上に立って、患者の健康を支援しなければなりません。

ここでは、自分らしさを踏まえてコントロールを続け、健康な生活を送れるようになるためのプログラムを紹介

図1　ストレスに伴う代謝性疾患の発症モデル



します。本プログラムの目的は、糖尿病を治したり肥満を改善することがすべてではありません。「新しい健康観」を身につけ、健康ランクを高めることを通して、結果として糖尿病や肥満の改善をもたらそうという「健康観変容プログラム」なのです。

「健康観変容プログラム」の基本理念

「健康観変容プログラム」では、まず健康を、従来の疾病生成理論にもとづく「病気でなければ健康」という二元的健康観（古い健康観、後述）ではなく、健康生成理論にもとづく「より高い健康状態」を目指すという一元的健康観（新しい健康観、後述）として捉えることが重要です。

本プログラムでは、この「新しい健康観」で行動変容（修正）を行ないます。これは、「新しい健康観」にもとづき、身体感覚や心理状態に対する「気づき」を体感する行動変容プログラムなのです。

それではこの行動変容プログラムの基本的考え方となる「新しい健康観」を「古い健康観」とどのように違うのか、みていきたいと思います（図2）。

(1)「古い健康観」（禁忌の健康観）

従来の「古い健康観」は、結核を始めとする感染症が健康阻害の重大要因であった時代の健康観です。これは、「病気でなければ健康である」という二元的健康観といえます。この視点から健康増進教育・指導をとらえた場合、疾病予防や健康増進のためには、「～しないこと」「～すべきである」といった禁止や節制、命令の言葉が羅列されることが多くなります。

私たちが病気になりたくない、健康になりたいと考えるのは、より快適な生活を送るための「手段」であり、健康になること自体が「目的」ではありません。しかし、禁止・節制・命令による健康行動は、健康そのものが「目的」となってしまい、その「目的」を達するためには、どのような苦行も厭わないという構図ができあがってしまいがちです。

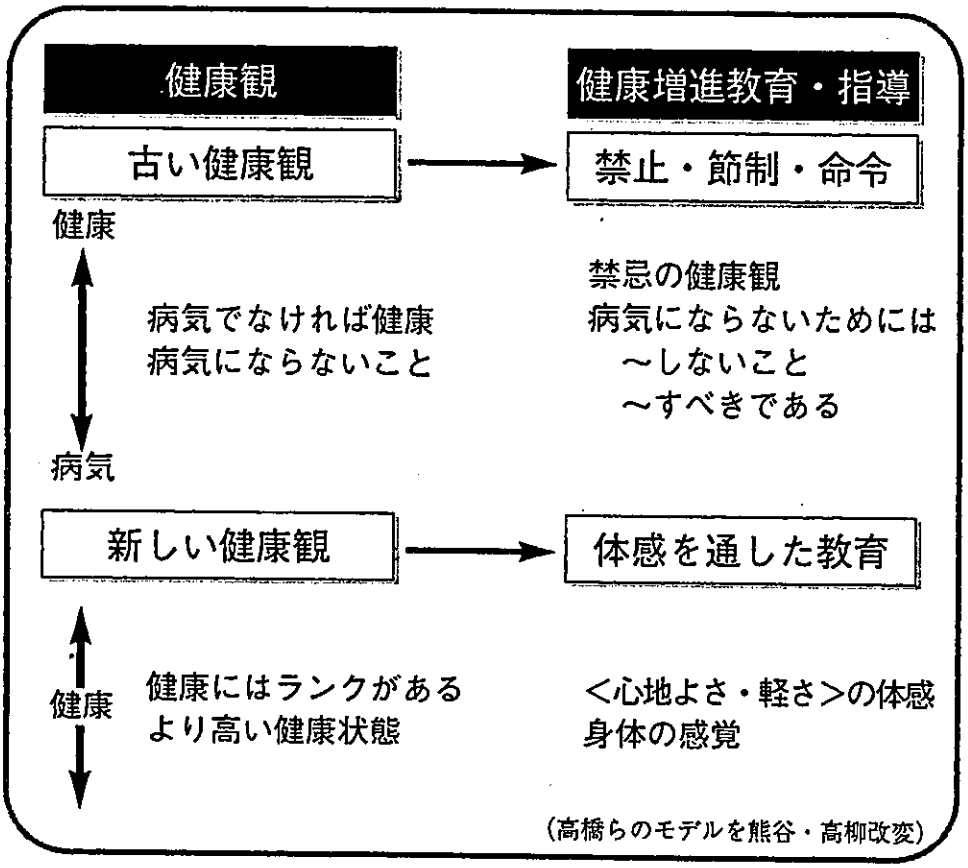
古い健康観

目的としての健康
‖
健康不安
↓
消極的・禁欲的・命令的な行動
↓
行動継続の中止

(2)「新しい健康観」（主体的な健康観）

それでは、「古い健康観」にとらわれないためには、健康をどのようにとらえればいいのでしょう。それには病気と健康を二元的にとらえず、健康のみを一元的にとらえることです。「古い健康観」での健康増進は、病気になら

図2　2つの健康観とそれにもとづく健康増進教育・指導モデル



（高橋らのモデルを熊谷・高柳改変）

ず、なるべく病気から離れていくことでした。そのため我慢すること、あるいは強制するような指導に傾きがちです。しかし「新しい健康観」が考える健康増進は、より高い健康状態を追求すること、健康に近づいていくことなのです。そのため高い健康状態を「心地よさ」という感覚でとらえ、健康にはランクがあることを体感し、また体感し得る体をつくるための指導が中心となってきます。

　これを時間軸で表現すれば、二元的にとらえる「古い健康観」では、病気が将来起こり得ることを前提として現在を問題にします。しかし一元的にとらえる「新しい健康観」は、まず現在の健康状態を問題にしていく健康観といえます。

　この「新しい健康観」にもとづく健康変容プログラムでは、「心地よさ」といった身体の感覚に対する「気づき」を経験させることで、健康にはランクがあり、より高いランクになれば、さらに心地よくなることを理解させ、それを体感するために身体をつくっていくよう、サポートしていきます。その結果として生活習慣病の改善がされればよいと考えています。

新しい健康観

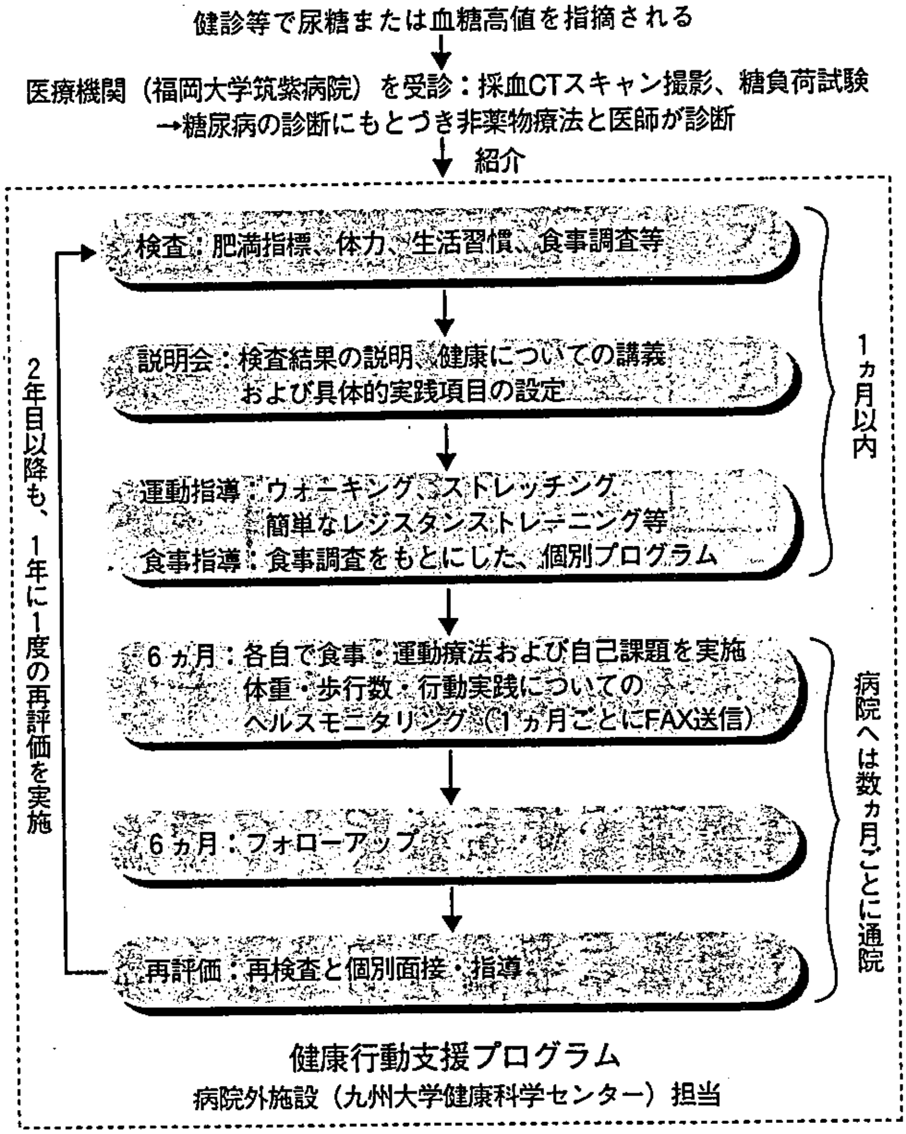
結果としての健康
‖
欲求・行動の習慣化の形成
↓
健康ランクの体感
↓
健康ランクの向上

プログラムの具体的な方法

　プログラムの具体的な内容とその流れを見ていきます（図3、P30）。プログラムに参加すると、1ヵ月間、検査・評価・診断を行ない、その結果を

もとに講義や自己課題の設定についての指導を行ないます。その後、個々人は具体的な行動課題を、修正もしくは変容するように日常生活を送ります。その行動課題の修正や変容をより確かなものにするために、また効果を認知するために、自分自身の健康状態や実践記録（体重、ウエスト、歩行数など）をチェックしてもらいます（セルフ・モニター、セルフ・チェック）。本プログラムでは、1年後には再度、検査と評価を行ない、効果を判定するとともに、これまで実践してきた自己課題の内容を再度吟味し、さらなる改善を目指します。

図3　プログラムの具体的な内容とその流れ



1　食事指導のコンセプト

食事指導では、「カロリー計算をしなければならない、好きな菓子類やお酒を止めなければならない」ととらえられがちですが、私どもは特定の食品を禁止する必要はなく、食事はおいしく楽しいものでなければならないと考えています。ですから食事内容の偏りやタイミングおよび食事癖についての調査をもとに、各人にとって「もっと上手な食べ方」、「もっと健康（元気）になる食事の仕方」を身につけてもらうため、栄養士が必要な情報提供を行ないつつ、健康レベルを上げるお手伝いをします。

2　運動指導のコンセプト

運動指導のコンセプトは、心地よい体、軽い体、心と体にずれのない状態、リラックスした状態とはどのようなものか実感してもらうことにあります。私たちは、「運動」「体育」と聞くと、ある定められた目的を達成すべく努力する姿を思い浮かべます。そして、その目的とは往々にして自分の体の外側にあります。

しかしここでは、自分の体が今どんな感じか、何を訴えてきているかを体感することのみが目的です。自由で軽い体の感じを大切にすることが、すべてのスタート点となります。そのため自宅でもできる簡単なストレッチやリラクセーション、レジスタンス（軽度の筋力）トレーニングを中心に行ないます。

糖症糖尿病患者への本プログラムの適用とその効果

プログラム対象者は、健診等で異常を指摘され、75g経口糖負荷試験（OGTT）を受けた未介入・未治療下にある新規の患者群であり、糖尿病専門医によって一定期間の非薬物療法下での運動・食事療法が適用であると判断された人です。医療機関にて診断・インフォームドコンセント（説明と同意）が得られたのち、病院外施設で肥満指標、体力および生活習慣等を測定・調査します。次に検査結果の説明と健康観の認知変容に関する講義を行ない、それらを考慮に入れた個人の自己課題を参加者自らが設定します（約120分）。自己課題の設定の際の留意点は、課題が具体的であること。また、短期間に達成可能であること等が挙げられます。

運動指導は、健康運動指導士による少人数での集団指導で1回のみ行ない（約90分）、各個人の最大酸素摂取量（VO_2max）の50%強度に相当する歩行運動に加え、リラクセーションおよびレジスタンストレーニングを指導します。食事指導については、病院外施設もしくは医療機関において、管理栄養士による個別指導（約60分／回）が最低2回行なわれます。そして食事癖調査を含む通常の食物摂取状況の把握を行なったのち、各個人の標準体重当たり25～30kcalを目安としてエネルギー摂取量が処方されます。

本プログラム参加から1年間が経過した184名を対象に、医療機関と病院外施設との連携モデルとして、本プログラムの継続評価および肥満や糖・脂質代謝についての効果評価を行ないました。1年間通院を継続し、本プログラムに再度参加した人は、全体の48%（83名／184名）でした。この成績は、ほかに比較する資料がないので、その有効性を明らかにできません。

しかしながら、非薬物療法下にある患者は極めて高い確率でドロップアウトすることを考慮すれば、本プログラム下にあれば、少なくとも約半数の患者が通院を継続する可能性があることを示しています。また、効果評価が実施できた73名では、少なくとも本プログラム管理下にあれば、肥満度の改善および体力の向上とともに、糖・脂質代謝指標に有意な改善が認められました（表1参照）。

表1　継続群（N＝73）におけるプログラム前後での身体的特徴の変化　（平均値±標準偏差、＊；$P<0.05$）

	プログラム前	プログラム後	
年齢（歳）	50.2±15.6	51.4±15.6	
BMI（kg／m²）	25.8±5.3	24.7±3.9	＊
体脂肪率（%）	26.5±12.2	24.7±10.9	＊
WHR	0.95±0.05	0.93±0.06	
皮下脂肪面積（cm²）	187.6±130.1	168.9±96.7	
内臓脂肪面積（cm²）	161.8±64.1	136.6±49.3	＊
VO_2max（mℓ／kg／分）	31.9±6.2	34.8±5.8	＊
FPG（mg／dℓ）	131.5±35.3	123.2±28.4	
FIRI（μU／mℓ）	8.3±6.8	6.4±5.5	＊
HOMA-IR	2.7±2.7	1.9±1.5	＊
AUCPG（μU／mℓ／時）	611.2±171.7	567.7±168.3	＊
AUCIRI（μU／mℓ／時）	127.4±145.0	108.7±92.4	
HbA_{1c}（%）	6.3±1.4	5.9±1.1	＊
TC（mg／dℓ）	220.4±38.3	214.2±35.7	
HDL-c（mg／dℓ）	47.1±11.9	53.7±15.0	＊
TG（mg／dℓ）	154.5±88.7	137.2±83.8	＊

BMI；body mass index、WHR；ウエストヒップ比、VO_2max；最大酸素摂取量、FPG；空腹時血糖値、FIRI；空腹時インスリン濃度、HOMA-IR；インスリン抵抗性スコアー、AUCPG；area under the curve for plasma glucose、AUCIRI；area under the curve for insulin、TC；総コレステロール、HDL-c；HDLコレステロール、TG；トリグリセリド

＊　＊

「～しなければ病気になってしまう」という「古い健康観」ではなく、「より心地よくなるためにこうしよう」という「新しい健康観」にもとづく本プログラムは、健康増進に有効であると考えます。今後もフォローアップ研究を継続していく予定です。

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Refractive Errors and Factors Associated with Myopia in an Adult Japanese Population

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Purpose: To investigate the refractive status and factors associated with myopia by a population-based survey of Japanese adults.

Methods: A total of 2168 subjects aged 40 to 79 years, randomly selected from a local community, were assessed in a cross-sectional study. The spherical equivalent of the refractive error was calculated and used in a multiple logistic regression analysis to evaluate the relationships between myopia and possible related factors.

Results: The mean (± SD) of the spherical equivalent was −0.70 ± 1.40 diopters (D) in men, and −0.50 ± 1.44 D in women. Based on ± 0.5 D cutoff points, the prevalence of myopia, emmetropia, and hypermetropia were 45.7%, 40.8%, and 13.5% in men, and 38.3%, 43.1%, and 18.6% in women, respectively. A 10-year increase in age was associated with reduced risk of myopia [men: odds ratio (OR) = 0.53, 95% confidence interval (CI): 0.44–0.62; women: OR = 0.65, 95% CI: 0.54–0.78]. In men, myopia was significantly associated with higher education (high school: OR = 1.6, 95% CI: 1.1–2.3; college: OR = 2.0, 95% CI: 1.3–3.1) and management occupations (OR = 1.6, 95% CI: 1.0–2.4). For women, high income (OR = 1.5, 95% CI: 1.1–2.2), and clerical (OR = 1.5, 95% CI: 1.0–2.4) and sales/service occupations (OR = 1.7, 95% CI: 1.1–2.6) were also associated with myopia.

Conclusions: The prevalence of myopia in a Japanese population was similar to that in other Asian surveys but higher than in black or white populations. Our study confirmed a higher prevalence of myopia among younger vs. older populations, and a significant association with education levels and socioeconomic factors. **Jpn J Ophthalmol 2003;47:6–12** © 2003 Japanese Ophthalmological Society

Key Words: Age, education level, myopia, refractive error, socioeconomic factors.

Introduction

Earlier studies have shown that the prevalence of myopia is higher in the Asian population than in black and white populations,[1] and several epidemiological studies have shown that both genetic factors, such as race[2] and family history,[2–5] and environmental factors, such as education level[6–8] and socioeconomic status,[9–11] are important risk factors for myopia. The prevalence of myopia seems to be increasing worldwide.[1,12] In particular, the incidence of myopia has increased rapidly in younger generations over the past few decades,[13–15] and the concurrent increase in formal education and white-collar occupations may be a reason for this increase.[1]

In Japan, however, there has been no population-based survey investigating the refractive status in an adult population. Although a nationwide glaucoma survey[16] showed the prevalence of refractive errors by age, other factors related to myopia have not yet been analyzed.

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In the present study, we investigated the refractive status of middle-aged to elderly populations living in two communities in Aichi prefecture, Japan. In addition, the relationships between myopia and several other factors, such as age, physique, education level, and socioeconomic status, were examined.

Materials and Methods

Data for the present report were obtained from a population-based survey of aging conducted in Obushi and Higashiura-cho, Aichi prefecture, Japan, by the National Institute for Longevity Sciences—the Longitudinal Study of Aging (NILS-LSA). Random sampling from the municipal register, which was stratified by age and sex, identified eligible subjects of the same racial and ethnic origin, aged from 40 to 79 years.

A detailed description of this study design has been reported elsewhere.[17] In brief, the NILS-LSA consists of clinical evaluations, body composition and anthropometry, physical functions, nutritional analysis, and psychological tests. Participants were interviewed at the research center on demographic characteristics, medical and ophthalmologic history, and self-reported vision problems. The Ethical Committee of the Chubu National Hospital reviewed and approved all procedures for the study, and a written informed consent was obtained from all subjects.

We analyzed the baseline data of NILS-LSA obtained between March 1997 and April 2000. During this period, 2267 people (1136 men and 1131 women)

Table 1. Characteristics of Participants

	Men (n = 1087)		Women (n = 1081)	
Characteristics	Mean	SD*	Mean	SD*
Age (years)	58.7	10.8	58.7	10.8
Height (cm)	164.7	6.3	151.5	6.0
Weight (kg)	62.3	9.1	52.6	8.3
Smoking (pack-years)	24.6	22.5	1.6	6.6
Refractive error of the right eye (spherical equivalent)				
40–49 years	−1.35	1.37	−1.22	1.37
50–59 years	−1.03	1.43	−0.67	1.33
60–69 years	−0.22	1.17	−0.09	1.37
70–79 years	−0.09	1.20	0.04	1.31
Total	−0.70	1.40	−0.50	1.44
	n	%	n	%
History of				
Hypertension	262	24.1	284	26.3
Diabetes	106	9.8	58	5.4
Household income (Yen)				
<6.5 million	412	37.9	448	41.4
6.5–10 million	376	34.6	290	26.8
>10 million	291	26.8	275	25.4
Education level				
Elementary school or junior high school	314	28.9	393	36.4
High school	438	40.3	430	39.8
College or university or higher	332	30.5	253	23.4
Occupation				
Expert	135	12.4	89	8.2
Management	204	18.8	6	0.6
Clerical	127	11.7	245	22.7
Sales, service	51	4.7	171	15.8
Physical labor	358	32.9	227	21.0
Security guard	24	2.2	0	0.0
Agriculture, forestry, fishery	47	4.3	62	5.7
Business on one's own	78	7.2	57	5.3
Housework	0	0.0	108	10.0
Unclassified	40	3.7	80	7.4

*SD: standard deviation.

participated in the NILS-LSA. We excluded participants with a previous history of cataract surgery and those without refractive error data, so that 2168 people (1087 men and 1081 women) were included in the present study.

As part of our standardized examination, an automated objective refraction test was performed on each participant with an AutoRefractor & Keratometer (ARK700A, NIDEK, Gamagori). Visual acuity was then measured with Landolt broken rings at 5 meters under standard lighting conditions, and measured initially using any corrective devices the participants were currently using. If the participant was unable to read the 1.0 equivalent line, refraction was performed using the results of the objective refraction as a starting point. The best-corrected visual acuity was found, and both the derived refractive data and the visual acuity were recorded. When the presenting acuity of the participant was 1.0 or better, the initial objective refraction was recorded as the subject's refractive data. The spherical equivalent (sphere + 1/2 cylinder) was used to calculate the refractive error. Because of the age of our study population, cycloplegia was not used.

Information on smoking habits, household income, education level, and lifetime occupation was obtained from the questionnaires filled out by the participants. Total pack-years smoked was defined as the number of cigarettes smoked per day divided by 20, multiplied by the number of years smoked. Any history of hypertension and diabetes was also recorded.

Myopia was defined as the spherical equivalent of ≤ -0.5 diopters (D). We further categorized the myopia as mild myopia (> -0.5 D to -3.0 D), moderate myopia (> -3.0 D to -6.0 D) and high myopia (≥ -6.0 D). Hypermetropia was defined as the spherical equivalent of more than +0.5 D, and emmetropia was defined as the spherical equivalent of +0.5 D or less but > -0.5 D. Because the spherical equivalents in the right and left eyes were highly correlated (Pearson's correlation: $r = 0.91$, $P < .0001$ in men; $r = 0.88$, $P < .0001$ in women), we present the data for only the right eye.

To estimate how other factors may be associated with refractive errors, we grouped household income and education level into three categories each, and occupation into 10 categories (Table 1).

For analysis, the values for the spherical equivalent of refractive errors, age, height, weight, and pack-years smoked were entered as continuous variables. The relationships among these variables were assessed using the Spearman correlation analysis. We used the Student t-test, analysis of variance, the Cochran-Mantel-Haenszel χ^2, and general linear regression (including trend tests) to assess the relationships between the spherical equivalent and other potential risk factors. Multiple logistic regression was used to determine whether these variables affected the risk of myopia. All statistical analyses were performed by sex because there were large differences between the sexes in several factors (eg, smoking habit or occupation). Data were analyzed using the Statistical Analysis System (SAS) release 6.12.[18]

Results

The characteristics of the study population are presented in Table 1. The mean age was 58.7 years for each sex. The mean (± SD) spherical equivalent of the refractive error was -0.70 ± 1.40 D in men and -0.50 ± 1.44 D in women. This constituted a significant difference between the sexes (t-test, $P = .001$). The older age groups had more hypermetropic refractive errors in both sexes ($P < .0001$ for trend).

The mean value for pack-years smoked was significantly greater for men than for women (t-test, $P < .0001$), and there were also significant differences in occupations between sexes ($\chi^2 = 478.3$, $P < .0001$). In particular, men did not list housework and women did not list guard work as lifetime occupations.

The distribution of the spherical equivalent of refractive error is shown in Figure 1. Based on the ± 0.5 D cutoff points, the prevalence of myopia, emmetropia, and hypermetropia were 45.7%, 40.8%, and 13.5% in men, and 38.3%, 43.1%, and 18.6% in women, respectively. This difference in distribution between sexes was also highly significant ($\chi^2 = 16.5$, $P = .0003$). The incidence of mild myopia was 37.9% in men and 30.5% in women, moderate myopia was

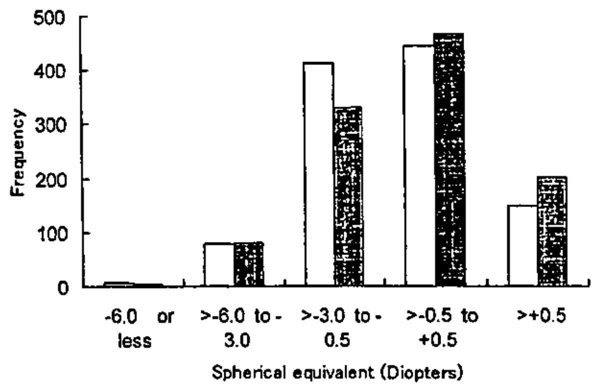

Figure 1. Distribution of refractive errors by sex. □ men women, ■.

7.2% and 7.3%, respectively, and high myopia was 0.6% and 0.5%, respectively.

The distribution of spherical equivalent by age groups and sex is shown in Figure 2. The prevalence of hypermetropia increased with age in both men (Cochran-Mantel-Haenszel χ^2 = 108.6, P < .001) and women (Cochran-Mantel-Haenszel χ^2 = 149.0, P < .001). For participants in their 40s, 1.4% of men and 1.1% of women showed hypermetropia, while the figures were 27.8% and 38.1% when they reached their 70s. Although the prevalence of hypermetropia was higher in women than in men in all age groups except for the 40–49-year group, the differences in data were not significant between sexes. The prevalence of myopia (spherical equivalent ≤ −0.5 D) decreased with advancing age in both men (Cochran-Mantel-Haenszel χ^2 = 118.3, P < .001) and women (Cochran-Mantel-Haenszel χ^2 = 87.6, P < .001). In the 40–49-year age group, 69.4% of the men and 60.2% of the women were myopic, while in the 70–79-year age group, only 28.6% of the men and 25.4% of the women were myopic.

A simple correlation analysis showed a significant positive association between age and the spherical equivalent of refractive errors for both sexes (P < .0001). Conversely, height and weight had a significant inverse association with the spherical equivalent for both sexes (P < .0001), and pack-years smoked was positively correlated with the spherical equivalent in men (P = .004), but inversely in women (P = .001). However, these significant associations, except for height in women, were not found when adjustments were made for age.

In the categorical variables, the participants with a history of hypertension had a lower mean spherical equivalent value than those without a history of hypertension (t-test, men: P = .017, women: P = .001). However, a history of diabetes had no significant influence on the mean spherical equivalent in either sex. A significant relationship between the spherical equivalent and household income was found (men: F = 29.0, P < .0001, women: F = 21.5, P < .0001), with the spherical equivalent decreasing as the household income increased (P < .0001 for trend). Similarly, a higher education level was associated with greater myopia in both sexes (men: F = 45.4, P < .0001, P < .0001 for trend; women: F = 22.3, P < .0001, P < .0001 for trend). There were also significant associations between the spherical equivalent and lifetime occupations (men: F = 7.7, P < .0001, women: F = 4.7, P < .0001).

Finally, multiple logistic regression analysis for the risk of myopia (spherical equivalent ≤ −0.5 D) using all variables was performed (Table 2). An increase in age of 10 years was associated with a 0.53 [95% confidence interval (CI): 0.44–0.62] and 0.65 (95% CI: 0.54–0.78) lower probability of having myopia in men and women, respectively. Men with a higher education were at higher risk for myopia: high school, odds ratio (OR) = 1.59, 95% CI: 1.10–2.29; college or higher, OR = 2.05, 95% CI: 1.33–3.14. In women, the highest income group was associated with a higher incidence of myopia (OR = 1.52, 95% CI: 1.05–2.18) compared with the lowest income group.

To assess the effect of occupation, we considered persons in the physical labor category as a reference group because this was the most frequent occupation in the present study (27.0% of the participants). The presence of myopia was associated with management occupations (OR = 1.55, 95% CI: 1.01–2.39) in men, and with clerical (OR = 1.54, 95% CI: 1.01–2.36) and sales/service (OR = 1.66, 95% CI: 1.06–2.61) occupations in women. No association was found in either sex between pack-years smoked, hypertension, or diabetes and the presence of myopia.

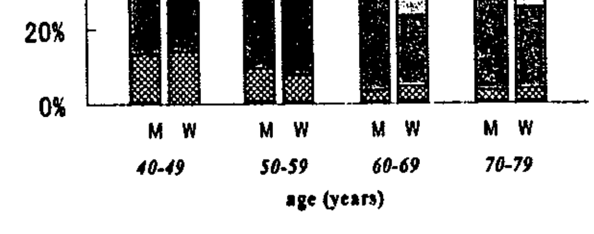

Figure 2. Refractive status, stratified by age and sex. Refractive status, spherical equivalent, are defined as: hypermetropia (> +0.5 diopters [D]), emmetropia (> −0.5 to +0.5 D), mild myopia (> −3.0 to −0.5 D), moderate myopia (> −6.0 to −3.0 D), high myopia (≤ −6.0 D). M: men, W: women. □: hypermetropia, □: emmetropia, □: mild myopia, ▩: moderate myopia, ■: high myopia, in descending order from top to bottom of each column.

Discussion

The main findings of this investigation in a large Japanese population are that the prevalence of myopia was 45.7% in men and 38.3% in women, and that there are significant independent associations be-

Table 2. Results of Multiple Logistic Regression for Risk of Myopia

	Men		Women	
Variables	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Age (10 years)	0.53	0.44–0.62	0.65	0.54–0.78
Height (10 cm)	1.24	0.93–1.65	1.14	0.85–1.53
Weight (10 kg)	0.82	0.68–0.98	0.98	0.81–1.18
Education level				
Elementary school or junior high school (reference)	1		1	
High school	1.59	1.10–2.29	1.21	0.85–1.71
College or university or higher	2.05	1.33–3.14	1.27	0.84–1.93
Household income (Yen)				
<6.5 million (reference)	1		1	
6.5–10 million	0.89	0.62–1.26	1.12	0.79–1.60
>10 million	1.04	0.72–1.51	1.52	1.05–2.18
Occupation				
Expert	1.48	0.91–2.41	0.68	0.38–1.22
Management	1.55	1.01–2.39	1.12	0.17–7.40
Clerical	1.52	0.95–2.42	1.54	1.01–2.36
Sales, service	1.56	0.81–3.01	1.66	1.06–2.61
Physical labor (reference)	1		1	
Security guard	1.08	0.42–2.81	N/A*	
Agriculture, forestry, fishery	1.70	0.83–3.45	1.07	0.52–2.17
Business on one's own	0.58	0.32–1.05	1.12	0.57–2.18
Housework	N/A*		0.78	0.45–1.38
Unclassified	1.78	0.84–3.77	1.00	0.56–1.79
Smoking (per 10-pack–years)	1.00	0.94–1.06	1.07	0.87–1.31
History of				
Hypertension	1.15	0.82–1.61	0.88	0.62–1.26
Diabetes	1.15	0.72–1.84	1.63	0.83–3.18

*N/A: not applicable

tween the presence of myopia and several socioeconomic factors.

There are many studies examining the distribution of refractive error and the risk factors for the refractive errors. In an adult population, it has been reported that there is a significant association between myopia and several different factors such as age,[6,7,9–11,16,19–24] family history,[2–5] education level,[6–8] socioeconomic status,[9–11] and cataracts.[9,11] The relationships between refractive error and height or weight are unconvincing, although eye size may be linked to body stature.[25] Other factors such as nutrition, ultraviolet exposure, use of drugs, cigarette smoking, hypertension, and diabetes might be associated with myopia, because they are associated with the prevalence of age-related cataracts.[26]

Previous population-based surveys reported a racial difference in the prevalence of myopia. The proportion of myopia is 17–26.2% in white populations[3,6,7,9,19,20] and 13–21.9% in black populations.[7,11,20] In contrast, the prevalence of myopia in East Asian countries is much higher. Wong et al[10] showed that the prevalence of myopia in Singapore Chinese people between 40 and 79 years of age was 38.7%, and Van Newkirk measured the prevalence in Hong Kong at approximately 40%.[27] In Japan, it was reported that 47.6% of people 40–69 years old were myopic.[16] The Visual Impairment Project study in Australia[9] concluded that people born in Southeast Asia had significantly higher rates of myopia than in any other geographical area, even after adjusting for age and education level. Our results showed that the prevalence of myopia in Japan is as high as in other Southeast Asian countries.

It has been suggested that genetic variations among races influence the prevalence of myopia in the groups studied.[1] Studies in twins also suggest the importance of genetic factors in myopia. In particular, a recent twin study in the United Kingdom by Hammond et al[5] indicated that the heritability for myopia was 84% to 86%, with the remaining 16% to 14% of the variance due to environmental factors.

Cross-sectional studies have shown that the prevalence of myopia is higher in recent years than in former times.[13–15] In particular, among East Asian countries, the prevalence of myopia has increased remarkably over the last few decades.[13,28]

Because it is highly unlikely that this rapid change could be explained by genetic factors alone, environmental factors are probably also important in the etiology of myopia. A possible reason for the rapid increase in myopia rates in Asian countries is the greater close work demands on the younger generation, such as increased formal education or the shift to white-collar occupations.[1] In fact, several longitudinal studies have revealed that reading or close work could cause refractive myopic shifts from childhood through adolescence.[29-31]

Similarly, we found a significant independent association between education level and the prevalence of myopia in men. The relationship between myopia and certain occupations was demonstrated by data on professionals and clerks in the Visual Impairment Project study,[9] professional and office workers among Singapore Chinese,[10] and with near-work–related occupations (professional, managerial, clerical, technical, electrical) in the Barbados Eye Study.[11] Our study showed similar results in people who stated they were in management or clerical occupations. Sales/service occupations in women also showed a significant relationship to myopia in the present study, which may be due to the indistinct boundary between clerical and sales/service occupations for women. These results seem consistent with the use-abuse theory.[1,32]

Our findings confirmed the age-related increase in hypermetropia with an associated age-related decrease in myopia, which has been reported in previous studies.[6,7,9-11,16,19-24] It was suggested that this trend toward hypermetropia was due to decreasing lens power with aging,[33] or an increasing optical density of the lens cortex making the lens more uniformly refractive.[34] Another possible explanation is that the relationship between age and refraction reflects a worldwide trend. Bengtsson et al[12] showed that a true hypermetropic shift did exist between 55 and 70 years of age; however, there was also a persistent worldwide trend toward myopia using a meta-analysis method. It was assumed that this worldwide trend for myopia is 0.01 D per year.

The relationship between refraction and stature is inconsistent. It was reported in one study that myopic subjects were taller than nonmyopic subjects.[35] In contrast, there was no significant association between height and refractive error after adjustment for sex in the Blue Mountains Eye Study.[19] Wong et al[25] showed that the refraction between tall and short people appeared to be similar, although taller persons tended to have longer globes. Similarly, the relationship that myopia was prevalent in taller and heavier persons in our univariate analysis seems to be apparent in our results. This may be due to the cohort phenomenon that younger persons are larger in physique and more myopic in refraction than elderly persons in Japan.

To the best of our knowledge, there are no available population-based studies on the association of refractive errors with hypertension or cigarette smoking. However, because a significant relationship between cataracts and myopia has been detected in several studies,[9-11] and cataracts appear to be associated with hypertension and smoking,[36] we assume that a history of hypertension or smoking has some influence on refractive errors. However, in our study, they were not significant independent factors affecting the prevalence of myopia. There was also no significant difference in refractive error between people with or without diabetes, which is consistent with the Beaver Dam Eye Study.[6] In contrast, a significantly higher prevalence of myopia in diabetics as compared to nondiabetics was found in two Danish studies.[37,38] Up to the present, longitudinal prospective studies investigating the influence of smoking, hypertension, and diabetes on refractive error have not been conducted.

There are some important limitations in the present study. First, these data were cross-sectional, with all parameters measured simultaneously. Therefore, it is difficult to make conclusive statements about a cause–effect relationship between refractive errors and the educational level or socioeconomic factors. A high education level may not only cause a myopic shift in refraction, but it also seems likely that those with myopia are more likely to choose a higher education level or close work. Second, although we did not have data on cataract status or family history of refractive errors, several studies have indicated the independent effect of family history[1,2] and cataract status[9-11] on refractive errors. Third, there was a selection bias in our population. Because the examinations of the NILS-LSA participants were performed at the National Institute for Longevity Science, those participants with limited activity level or living in an institution may not have been able to travel and participate in our survey, which may have influenced our findings.

In conclusion, we showed the prevalence of refractive errors in a middle-aged and elderly Japanese population. The frequency of myopia was 45.7% in men and 38.3% in women, which are findings similar to those in other Asian surveys and higher than those found in black or white populations. As previously reported, our study confirmed a higher prevalence of myopia among the younger population than the elderly. It was also found that myopia was independently associated with education level and socioeconomic factors. Changing environmental factors, such as an increase in close work, may be one of the reasons for the higher prevalence of myopia in the younger generation. Unfortunately, the cross-sectional approach in the present study limits our conclusions. However, prospective research by the NILS-LSA should provide further information on myopia and its risk factors.

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Relationships of Resting Energy Expenditure with Body Fat Distribution and Abdominal Fatness in Japanese Population

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Abstract Body fat distribution and abdominal fatness are indicators of risks for coronary heart disease. However, the relationships between resting energy expenditure (REE) and the body fat distribution or the abdominal fatness are unclear. We examined the relationships of REE with whole-body fat distribution (waist, hip and waist-to-hip ratio: WHR) and abdominal fatness (intra-abdominal fat: IF and subcutaneous fat: SF) after adjustment for body composition. 451 men and 471 women were subdivided into two groups, 40–59 years: middle-aged group and 60–79 years: elderly group. REE was measured by an indirect calorimetry system. Percentage of fat mass (%FM), fat mass (FM) and fat-free mass (FFM) were assessed by a dual-energy x-ray absorptiometry method. The IF area (IFA) and SF area (SFA) at the level of the umbilicus were measured using computed tomography. Circumference of waist and hip were measured in a standing position. The WHR, waist circumference and SFA did not significantly ($p>0.05$) associate with the REE after adjusting for FM, FFM and age in any of the groups. The adjusted REE was significantly and inversely correlated with hip ($r=-0.159$, $p<0.05$) and IFA ($r=-0.131$, $p<0.05$) in the elderly men. These results suggest that lower REE may contribute to greater hip and IFA rather than WHR and waist in elderly men. *J Physiol Anthropol 22 (1): 47–52, 2003* http://www.jstage.jst.go.jp/en/

Keywords: resting energy expenditure, body fat distribution, waist-to-hip ratio, intra-abdominal fat area

Introduction

Obesity occurs when energy intake exceeds energy expenditure over a long period. Energy expenditure consists of physical activity, diet-induced thermogenesis and resting energy expenditure (REE). REE is the largest component of total daily energy expenditure and maintains the basic physiologic functions (e.g., heart, renal, hepatic and muscle functions, respiration) [Goran, 2000]. A longitudinal study [Ravussin et al., 1988] observed that the initial REE negatively correlates with the change in body weight. Several cross-sectional studies [Albu et al., 1997; Carpenter et al., 1998; Forman et al., 1998; Foster et al., 1997] found that a lower REE might be related to a higher prevalence of obesity.

Upper-body obesity (android-type of obesity) was found to be more greatly associated with various obesity-related complications, compared with lower-body obesity, by Vague [1956]. Upper-body obesity is generally estimated by the waist-to-hip ratio (WHR) as an index of body fat distribution. Several studies revealed that WHR was closely associated with risk factors for coronary heart disease (CHD), e.g., impaired glucose tolerance, insulin resistance, lipoprotein metabolic disorder and hypertension [Kissebah et al., 1982; Kissebah and Peris, 1989; Micciolo et al., 1991]. More recently, intra-abdominal fat area (IFA) and subcutaneous fat area (SFA) at the L4-L5 level were estimated using computed tomography [Tokunaga et al., 1983]. An increase in IFA has been demonstrated to be closely associated with CHD risk factors, e.g., hyperlipidemia [Nakamura et al., 1994], hypertension [Kanai et al., 1990] and low insulin sensitivity [Macor et al., 1997]. Thus, IFA is an important indicator for predicting the prevalence of CHD risk factors.

Whether REE plays a role in the alteration in body fat distribution and abdominal fatness is controversial. Several investigators [Tataranni et al., 1994; Weststrate et al., 1990] found significant and positive correlations between REE and WHR or the waist-to-thigh ratio adjusted for body composition, whereas some [Armellini et al., 1992; Schutz et al., 1992] did not. To our knowledge, studies investigating the relationships between REE and IFA using computed tomography (CT) are rare [Macor et al., 1997; Nicklas et al., 1995]. The studies by Macor et al. [1997] and Nicklas et al. [1995] used obese people as the subjects; therefore, there is no study for non-obese and healthy population. Moreover, very few studies have clarified the effects of sex and age on the relationships between REE and WHR or IFA, and the sample sizes of these studies were insufficient for the findings to be generalized. Therefore, the aim of this study was to examine the influence of REE on the body fat distribution (WHR, waist and hip circumferences) and abdominal fatness (IFA and SFA) assessed by the new method (CT) in a relatively large sample size of the Japanese population.

It may be necessary to take menopausal transition into consideration in women. A longitudinal study [Poehlman et al., 1995] in American women showed that the normal menopausal transition decreased in REE by approximately 100 kcal/day compared to premenopausal women. Thus, we also examined whether the menopausal transition has any influence on REE and various physical variables in Japanese women.

Methods

Subjects

The subjects were 613 men and 564 women who participated in the second wave examination of NILS-LSA (National Institute for Longevity Sciences, Longitudinal Study of Aging) from April 2000 to May 2001. They were age- and sex-stratified random samples aged from 40 to 79 years and living in the neighborhood of the NILS. Details of the NILS-LSA have been described elsewhere [Shimokata et al., 2000]. Patients who had concomitant renal, hepatic or cardiac disease or diabetes mellitus, or who were being treated with drugs such as beta blockers, which could affect the variables of the study, in particular REE, were excluded. Additionally, patients with thyroid disease, assessed by careful clinical and laboratory estimation (e.g., history of thyroid disease and level of free thyroxine and free triiodothyrinine) were also excluded. Subsequently, the numbers of subjects who took part in this study were 451 men and 471 women. The subjects were subdivided into two groups in each sex by age (middle-aged group: 40 to 59 years and elderly group: 60 to 79 years). The aim and design of the study were explained to each subject before they gave their written informed consent. The study was approved by the Committee of the Chubu National Hospital. All measurements were performed at the Chubu National Hospital.

Anthropometric variables

Body weight was measured to the nearest 0.01 kg using a digital scale, height was measured to the nearest 0.1 cm using a wall-mounted stadiometer, and BMI was calculated as weight (kg) divided by height squared (m^2). Circumference of the waist was measured at the level of the umbilicus to the nearest 0.1 cm with the subjects in the standing position.

Resting energy expenditure (REE)

REE was estimated by a computerized, open-circuit, indirect calorimetry system (V_{max} 29, SensorMedics) that measured resting oxygen intake and resting carbon dioxide excretion using a ventilated canopy. The subjects were asked to refrain from all vigorous activity before the measurement. REE measurement was performed during the morning (between 9:00 and 12:00) after an overnight fast in a comfortable and thermoregulated room with an examiner and a subject. After a 15-minute steady-state period, values were recorded each minute for 10 minutes. Twenty-four hour energy expenditure due to REE was calculated using an equation derived by Bursztein et al. [1989]:

$$\text{REE (kcal/24 h)} = [3.581 \times \dot{V}O_2\,(\text{L/min}) + 1.448 \times \dot{V}CO_2\,(\text{L/min}) - 0.002] \times 1440\,\text{min}$$

Body composition

Whole-body fat mass (FM), fat-free mass (FFM) and percentage FM (%FM) were assessed by dual-energy x-ray absorptiometry (QDR-4500, Hologic). Transverse scans were used for the measurement of FM and FFM, and pixels of soft tissue were used to calculate the ratio (R value) of mass attenuation coefficients at 40 to 50 keV (low energy) and 80 to 100 keV (high energy), using software version 1.3Z.

Abdominal fat area

The IFA and SFA were measured at the level of the umbilicus (L4-L5). All CT scans (SCT-6800TX, Shimadzu) were performed with the subjects in the supine position. The IFA and SFA were calculated using a computer-software program (FatScan, N2 system) [Yoshizumi et al., 1999]. A region of the SF layer was defined by tracing its contour on each scan, and the range of CT values (in Hounsfield units) for fat tissue was calculated. Total fat area was calculated by delineating the surface with the mean CT value plus or minus 2 standard deviations. The IFA was measured by drawing a line within the muscle wall surrounding the abdominal cavity. The SFA was calculated by subtracting the amount of IFA from the total fat area. The intra-class correlation for repeated IFA determinations in our laboratory is 0.99. The IFA-to-SFA ratio (ISR) was calculated.

Definition of peri- and postmenopausal women

Menopause is defined as the permanent cessation of menstruation resulting from the loss of ovarian follicular activity. Thus, the criterion to define the postmenopausal state is the absence of menses for at least 12 months [Wich and Carnes, 1995]. Perimenopausal women were defined as the women who were not clearly diagnosed at the menopausal state.

Data analysis

Values are expressed as mean±standard deviation (SD) in the tables. Differences between age groups, or between sexes were tested using the Student's t-test. Relationships between REE and age, the body fat distribution or anthropometric variables were assessed by Pearson's correlation coefficients. Partial correlation coefficients adjusted for age, FM and FFM were calculated to assess the relationships between REE and WHR, waist circumference, hip circumference, IFA or SFA for

Table 1 Physical characteristics of the subjects by sex and age group

		Men (n=451)		Women (n=471)		Sex difference	
		Middle-aged (n=222)	Elderly (n=229)	Middle-aged (n=233)	Elderly (n=238)	Middle-aged	Elderly
Height	m	1.68±0.06	1.63±0.1[1]	1.54±0.05	1.50±0.1[1]	Men>Women[2]	Men>Women[2]
Weight	kg	65.1±9.2	59.6±8.2[1]	53.9±7.9	51.2±8.2[1]	Men>Women[2]	Men>Women[2]
BMI	kg/m^2	23.1±2.8	22.5±2.8[3]	22.7±3.4	22.8±3.2	NS	NS
%FM	%	20.6±4.5	21.4±4.3	30.3±5.0	31.7±4.8[4]	Women>Men[2]	Women>Men[2]
FM	kg	13.6±4.4	12.9±3.8	16.6±4.6	16.5±4.7	Women>Men[2]	Women>Men[2]
FFM	kg	51.4±6.0	46.7±5.5[1]	37.4±4.3	34.7±4.3[1]	Men>Women[2]	Men>Women[2]
REE	kcal/24 h	1414±202	1284±198[1]	1144±186	1078±163[1]	Men>Women[2]	Men>Women[2]
REE/weight	kcal/24 h/kg	21.7±3.1	21.4±3.0	21.1±3.0	21.0±3.3	NS	NS
REE/FFM	kcal/24 h/kg	27.3±3.6	27.2±3.5	30.4±3.9	30.8±4.0	Women>Men[2]	Women>Men[2]
Waist	cm	84.4±7.8	84.0±8.0	81.4±8.7	85.1±9.5[4]	Men>Women[5]	NS
Hip	cm	93.3±5.1	90.5±4.7[1]	91.8±5.0	89.7±5.6[1]	Men>Women[6]	NS
Waist-to-hip ratio		0.90±0.05	0.93±0.06[4]	0.89±0.07	0.95±0.07[4]	NS	NS
IFA	cm^2	86.1±45.9	93.9±55.0	51.3±33.1	74.8±38.4[4]	Men>Women[2]	Men>Women[2]
SFA	cm^2	109.5±46.8	101.9±41.4	160.5±66.3	166.2±63.4	Women>Men[2]	Women>Men[2]
IFA-to-SFA ratio		0.81±0.37	0.93±0.40[7]	0.32±0.15	0.47±0.21[4]	Men>Women[2]	Men>Women[2]

Values are given as mean±SD.
%FM: percentage of fat mass, FM: fat mass, FFM: fat-free mass, REE: resting energy expenditure, IFA: intra-abdominal fat area, SFA: subcutaneous fat area.
[1] Significantly smaller than middle-aged group ($p<0.001$).
[2] Significant difference between men and women ($p<0.001$).
[3] Significantly smaller than middle-aged group ($p<0.05$).
[4] Significantly larger than middle-aged group ($p<0.001$).
[5] Significant difference between men and women ($p<0.01$).
[6] Significant difference between men and women ($p<0.05$).
[7] Significantly larger than middle-aged group ($p<0.01$).

each sex and age group. Additionally, the effect of the menopausal transition on the body fat distribution or anthropometric variables was assessed by an analysis of covariance. In the analysis of covariance, we used age as the covariate because a significant difference was observed in age between pre- (45±5 y) and post menopause (54±5 y) in the middle-aged women. Twenty perimenopausal women were excluded from the analyses. In each statistical analysis, probability values below 0.05 were regarded as significant. Data were analyzed with the Statistical Analysis System (SAS) release 6.12.

Results

Table 1 shows the physical and anthropometric characteristics of the subjects. The results are presented by sex and age, which indicate age and sex differences derived from the Student's *t*-test. REE was smaller in women or elderly subjects compared to men and middle-aged, respectively. Although no difference was found in REE divided by FFM (REE/FFM) between the middle-aged and elderly groups, sex differences existed in both the two age groups.

The possible role of the menopausal transition as a confounding factor in the relationships between REE and body fat distribution or physical variables was examined by analysis of covariance using pre- (n=109) and postmenopausal women (n=104) in the middle-aged group. Table 2 shows no differences in REE (1121 kcal/24 h and 1141 kcal/24 h in pre- and postmenopausal women, respectively), FM (16.4 kg and 16.7 kg), FFM (37.8 kg and 36.9 kg), WHR (0.88 and 0.89), waist circumference (81.1 cm and 81.6 cm), hip circumference (92.2 cm and 91.2 cm), IFA (51.7 cm^2 and 51.5 cm^2) and SFA (154.1 cm^2 and 166.0 cm^2).

Because no menopausal effect was found in REE or any physical variables in the middle-aged women, the menopausal transition was not taken into consideration in the following analyses (Tables 3 and 4).

Table 3 shows the correlation coefficients of age, body composition, body fat distribution and anthropometric variables with REE. FFM had the highest correlation coefficients (r=0.496 to 0.616) of all. REE did not correlate with age in the elderly women or ISR in any of the groups.

Table 4 shows the partial correlation coefficients of the body fat distribution (WHR, waist and hip circumferences) or abdominal fatness (IFA and SFA) with REE adjusted for age, FFM and FM. Table 4 indicates that the WHR, waist circumference and SFA did not significantly ($p>0.05$) associate with the REE after adjusting for FM, FFM and age in any of the groups. Elderly men had a significant and inverse correlation ($r=-0.159$, $p<0.05$) between the hip and REE. IFA inversely correlated ($r=-0.131$, $p<0.05$) with the adjusted REE in the elderly men. No association was found in

Table 2 Comparison of resting energy expenditure, fat mass, fat-free mass, waist-to-hip ratio, waist, hip, intra-abdominal fat area and subcutaneous fat area between pre and postmenopausal women after adjusting for age.

		Premenopausal	Postmenopausal	Group difference
REE	kcal/24 h	1121±166	1141±175	NS
FM	kg	16.4±4.5	16.7±4.7	NS
FFM	kg	37.8±4.4	36.9±4.6	NS
WHR		0.88±0.07	0.89±0.07	NS
Waist	cm	81.1±8.6	81.6±8.8	NS
Hip	cm	92.2±5.1	91.2±5.2	NS
IFA	cm^2	51.7±33.6	51.5±32.9	NS
SFA	cm^2	154.1±62.8	166.0±63.5	NS

Values are given as mean±SD.
REE: resting energy expenditure, FM: fat mass, FFM: fat-free mass, WHR: waist-to-hip ratio, IFA: intra-abdominal fat area, SFA: subcutaneous fat area.

Table 3 Correlation coefficients of age, body composition, fat distribution and anthropometric variables with REE

	Men		Women	
	Middle-aged	Elderly	Middle-aged	Elderly
Age	−0.215[1]	−0.204[1]	−0.198[1]	0.005 NS
BMI	0.462[2]	0.430[2]	0.481[2]	0.458[2]
FM	0.369[2]	0.309[2]	0.409[2]	0.382[2]
FFM	0.496[2]	0.606[2]	0.616[2]	0.565[2]
Waist	0.411[2]	0.415[2]	0.405[2]	0.420[2]
Hip	0.432[2]	0.436[2]	0.526[2]	0.430[2]
Waist-to-hip ratio	0.244[2]	0.286[2]	0.182[2]	0.270[2]
IFA	0.320[2]	0.219[2]	0.319[2]	0.247[2]
SFA	0.279[2]	0.295[2]	0.271[2]	0.303[2]
IFA-to-SFA ratio	−0.002 NS	−0.011 NS	0.112 NS	0.005 NS

FM: fat mass, FFM: fat-free mass, IFA: intra-abdominal fat area, SFA: subcutaneous.
[1] $p<0.01$.
[2] $p<0.001$, significant relationship between REE and each variable.

Table 4 Partial correlation coefficients of resting energy expenditure with body fat distribution and abdominal fatness after adjustment for age, FFM and FM

	Men		Women	
	Middle-aged	Elderly	Middle-aged	Elderly
Waist-to-hip ratio	0.117[1]	0.123[2]	0.029	0.102
Waist	0.105	0.044	0.069	0.099
Hip	−0.057	−0.159[3]	0.054	−0.044
IFA	−0.052	−0.131[3]	−0.040	−0.067
SFA	−0.039	−0.016	−0.090	0.002

IFA: intra-abdominal fat area, SFA: subcutaneous fat area.
[1] $p=0.07$.
[2] $p=0.06$.
[3] $p<0.05$, significantly correlate with REE.

the women or middle-aged men between REE and IFA or SFA.

Discussion

The purpose of the present study was to examine the relationship of REE with the body fat distribution and the abdominal fatness by sex and age group, and to confirm whether the menopausal transition has an influence on REE, body composition, the body fat distribution and the abdominal fatness in Japanese women. REEs divided by FFM (see Table 1) of this study were near by those (unit is kcal/24 h/kg, men: 28.4, women: 31.2–33.5, obese men: 29.2, obese women: 30.7) in previous studies [Tataranni et al., 1994; Weststrate et al., 1990]. Table 3 shows that REE is strongly associated with body composition (FM and FFM) and age except for in the elderly women, which supports the findings of the previous studies [Armellini et al., 2000; Karhunen et al., 1997; Luhrmann et al., 2001; Neuhauser-Berthold et al., 2000]. Thus, the REE adjusted for FFM, FM and age was used in this study. The major findings were that: 1) the menopausal transition did not influence REE, body composition, body fat distribution or abdominal fatness in Japanese women; 2) no relationship was found between the waist circumference and REE in any groups; 3) the hip circumference and IFA were negatively and significantly associated with REE in the elderly men, which indicates that the hip circumference and IFA are greater in the subjects with lower REE.

Concerning the menopausal transition of the middle-aged women, Poehlman et al. [1995] reported that natural menopause was observed to be associated with reduced REE in a 6-year follow-up longitudinal study. They also found that this reduction was mainly attributable to a decrease in FFM [Poehlman and Tchernof, 1998]. In the present study, as shown in Table 1, REE and FFM decreased in parallel with aging. Additionally, Table 2 indicates that body composition, body fat distribution and abdominal fatness are not affected by the menopausal transition when adjusted for age. That is, REE and various physical variables were more strongly affected by aging itself rather than by the menopausal transition. It is probably for these reasons that no difference was found in REE between the pre- and postmenopausal middle-aged women of the present study.

WHR has been traditionally used as an index of upper-body obesity [Armellini et al., 1992; Nicklas et al., 1995; Schutz et al., 1992; Weststrate et 1990]. Weststrate et al. [1990] found that REE adjusted for FFM and FM was positively associated with WHR in a group of premenopausal obese women. Tataranni et al. [1994] used the waist-to-thigh ratio (WTR) in obese men and also observed a significant and positive correlation between WTR and REE. Luhrmann et al. [2001] also found in elderly people that REE showed a significant increase with increasing WHR. Arner [1995] observed that the rate of lipolysis was relatively lower in the subcutaneous femoral/gluteal region and higher in the abdominal region. Therefore, the higher activity of the abdominal fat, e.g., the