her to engage in beneficial health behaviors (Lewis & Rook, 1999). For example, a wife may be critical of her diabetic husband for not following an appropriate diet (Krause, 2001). Indeed, Krause, Goldenhar, Liang, Jay, and Maeda (1993) found that negative interactions predicted more frequent exercise among older Japanese adults. Perhaps negative interactions would potentially contribute to discouraging health-compromising behavior and promoting health-enhancing behavior.

Future Directions

Some limitations should be kept in mind when our findings are interpreted. First, Lawrence and Jette (1996) described the multistep pathway in the disablement process: Presence of disease leads to anatomic and structural abnormalities, which in turn lead to restrictions in basic physical and mental actions, which then lead to difficulty performing ADLs. Analyses using a 2-point assessment method, as in our study, are too simple to examine such a multistep disablement process. Second, we did not pursue gender differences in the effects of HPs to avoid the complicated interpretation of a four-way interaction (HP × Age × Gender × Time). However, compared with men, women tend to report poorer physical health associated with chronic illness (O'Neill & Morrow, 2001) and more depressive symptoms (Nolen-Hoeksema, Larson, & Grayson, 1999). An elaborate analysis concerning these issues would modify and extend our findings.

Despite these limitations, the findings garnered from the present study add several specific points to the literature examining relationships between HPs and their negative consequences. Whereas most studies have restricted their sample to older adults or analyzed data by using age just as one of the confounders, this study made clear that the impact of HPs differs across age groups. Moreover, we highlight the importance of taking into account the type and source of social interactions when we are investigating how they moderate the impact of HPs. Although the results suggest that the relationships among HPs, everyday activities, and mental health are more complex than generally conceived, that is what makes it so challenging for researchers and professionals who are interested in stress and the development process in adulthood.

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原著

地域在住の中高年者の抑うつに関連する要因
――その年齢差と性差――

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Age and gender differences in factors related to depressive symptoms among community-dwelling middle-aged and elderly people

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This study was conducted to identify factors associated with depressive symptoms among males and females in two age groups; the middle-aged (40-59 years) and elderly (60-79 years). Subjects were 2 211 community-dwelling people (1 115 males and 1 096 females). Depressive symptoms were estimated by Center for Epidemiologic Studies Depression Scale (CES-D). Marital status, self-rated health, activities of daily living, age awareness, locus of control, and social support were assessed using self-administered questionnaires and interviews. In all groups, poor subjective health and external locus of control showed significant positive association with depressive symptoms. Age awareness was associated with depressive symptoms in female groups. Impairment of instrumental activities of daily living and lower social support were associated with depressive symptoms in the elderly groups. The findings suggested that there might be age and gender differences in the impact of factors associated with depressive symptoms.

Key words: middle-aged, elderly, gender, depressive symptoms, Center for Epidemiologic Studies Depression Scale.

老年期は，他の年齢層と比較して抑うつ状態の出現率が高いといわれている．多くの疫学調査でも，高齢者において抑うつ状態有症率の高いことが報告されている（Barusch, Rogers, & Abu-Bader, 1999；新野，1988）．老年期に抑うつ状態が多いのは，身体的健康及び経済的自立の損失，さらに定年退職や死別などによる社会や他者とのつながりの喪失が多くなることが関与するといわれるが（長谷川，1987），さらに詳しくその原因や構造を知るためには，老年期における抑うつの発生にかかわる要因について厳密に検討することが必要となる．

老年期の抑うつに関連する要因については，これまで様々な側面が論じられてきた．基本属性要因との関係では，性別（川本・土井・山田・小国・岡山・鶴岡・佐藤・梶井，1999; Zung, Broadhead, & Roth, 1993），婚姻状態（Pahkala, 1990）との関連があげられ，女性であることや，配偶者を持たないことが抑うつに関連するといわれている．身体的要因との関係では，うつ病と身体障害の関連（滝沢・須賀・森田・内藤，1988）や，日常生活の活動性が低い者に抑うつ状態の者が多い（井原，1993；村岡・生地・井原，1996）ことが指摘されている．社会的要因との関係については，親密な友人関係や社会への参加度（村岡他，1996; Pahkala, 1990），及びソーシャル・サポート（増地・岸，2001）が，抑うつやうつ病と関連するという報告がみられる．また，内的統制力の低さは老年期に特徴的な問題と考えられ，抑うつとの関連が指摘されている（Baum & Boxley, 1983）．

一方，老性自覚とは“加齢による心身の変化を主観的にどのように自覚しているか（中山・藤野，1994, p. 22）”であるが，人は中年期の頃から，“もう若くはない”，“この頃，年をとったと思う”などの自覚体験が契機となり，新たに体験した自己と，それまで自分が抱いていた内的な自己とのギャップによる葛藤から，無力感や抑うつ感，心気症状を示す場合がある．特にいつまでも若くありつづけることに価値をおく社会においては，老性自覚と抑うつとの関連は強いといえよう．しかし，老性自覚体験が中年期から老年期の抑うつ関連要因の一つであることを検討した研究は少ない（Baum & Boxley, 1983）．Baum & Boxley（1983）は，高齢者の場合，年をとっていると自己を見なすことは抑うつに関係することを明らかにしたが，Linn & Hunter（1979）は，社会的地位や障害の程度などの変数を調整すると，年をとっていると感じることと，抑うつとの関係は見出せないとしている．

以上のように，老年期には様々な要因が抑うつと関連することが指摘されている．しかし，これまでの研究は高齢者に対象を限定した研究が多く，中年期と老年期の差異を検討するというような，広範な年齢層を含んだ詳細な検討は少ない．老年期の抑うつとの関連

が指摘されている変数の中には，老年期特有の変数，あるいは他の年齢においても同様の関連がみられる変数が混在している．また，抑うつに関連する要因は年齢や性別とも強く関連するものが多いため，各年齢や性により，それぞれの要因が及ぼす影響の強さが異なる可能性がある．従って，本研究は，老年期の抑うつ関連要因を明らかにするために，中年期との比較，及び性差を検討することに焦点をおく．また，上記のように複数の要因が抑うつに影響すると指摘されているにもかかわらず，身体的要因や心理社会的要因などそれぞれの領域を別個に扱った研究が多く，各要因における相互間の関連を考慮した上で，総合的に抑うつとの関係を検討したものは少ない．そこで，これまでに関連が指摘されている要因を幅広くとらえ，これらの変数の相互関連を考慮し，中年期から老年期の男女の抑うつに関連する要因の特徴を探索的に示すことを第2の焦点とする．すなわち，本研究の目的は，地域在住の40歳から79歳の住民2267名に対し大規模な調査を行い，上記2点に焦点づけ，抑うつに関連する要因の年齢差及び性差を明らかにすることである．

方　法

調査対象

本研究の対象者は，国立長寿医療研究センターが行っている“老化に関する長期縦断疫学調査”(the National Institute for Longevity Sciences-Longitudinal Study of Aging: NILS-LSA) (Shimokata, Ando, & Niino, 2000) の第1回目調査（1997年11月－2000年4月）に参加した地域住民2267名のうち，分析項目すべてについて有効回答が得られた者2211名（男性1115名，女性1096名）である．

NILS-LSAは，医学・身体組成・運動機能・心理・栄養の各領域における様々な加齢変化を追跡し，正常な老化の進行過程を経時的に記録することを目的とした研究プロジェクトであり，本研究はその成果の一部である．対象者の選定については，センター近隣の愛知県大府市（人口約7万人）及び知多郡東浦町（人口約4万人）を対象地域とし，自治体の協力を得て住民台帳から40－79歳の7855名を性，年代別に層化無作為抽出した．この地域は，名古屋市南部に位置し，大都市のベッドタウン及びトヨタグループを中心とした機械工業地帯として発展を遂げる一方，果樹栽培が盛んな地帯や田園地帯を多く残している．平成15年の住民基本台帳・外国人登録による調査では大府市の40—79歳の人口は，40代8945人（26.3%），50代11535人（34.0%），60代8721人（25.7%），70代4763人（14.0%）である．また，平成12年の国勢調査より東浦町の40—79歳の人口は，40代5749人（27.8%），50代7240人（35.0%），60代4990人（24.1%），70代2703人（13.1%）であり（カッコ内はいずれも40—79歳の全人口を100とした割合），共に50代が多い構成になっている．しかし，我々の調査では性年齢別の比較を容易にするために，男女及び10歳刻みの年代で分けた八つの群に含まれる人数がほぼ同数になるように対象者の抽出，募集を行った．そのため，対象者の性年齢構成は地域を代表する訳ではないことに留意されたい．

抽出した7855名には，郵送にて調査の説明会への参加の意思についての問い合わせを行ったが，問い合わせ時にすでに65名が死亡ないし対象地域外へ転出していた．問い合わせ可能であった7790名のうち，3434名から回答が得られ，参加拒否の回答は881名であった．参加の意思のあった2553名のうち2510名が説明会に参加し，2267名が調査への参加に合意，インフォームドコンセントに署名した上で実際に調査に参加した．説明会への参加を呼びかけた者の29.1%が参加し，回答が得られた者からの参加率は66.0%であった．

対象者の学歴は，老年期女性のみ中卒者（52.0%）が多かったが，中年期男女と老年期男性は，過半数（55.7—85.6%）が高卒以上であった．職業に関しては，中年期男性では，技能・労務職（30.9%），事務・専門的技術職（27.3%），管理職（21.8%）が多く，老年期男性では，無職（60.2%）が多くを占め，有職者では，技能・労務職（9.4%），事務・専門的技術職（6.9%），農林漁業職（6.0%）が多かった．中年期女性では，主婦またはパート職（70.8%）が最も多く，有職者（パート職含む）のうち，事務・専門技術職（22.1%），サービス・販売職（15.0%）が多かった．老年期女性では，主婦またはパート職（61.8%）が多く，無職が27.9%，農林漁業職が5.9%であった．

NILS-LSAについては，国立療養所中部病院倫理委員会の承認が得られている．

調査内容

抑うつの測定　抑うつ状態の評価にはCenter for Epidemiologic Studies Depression Scale（以下CES-D; Radloff, 1977）の日本語版（島・鹿野・北村・浅井，1985）を用いた．この尺度は，米国国立精神衛生研究所において開発された疫学調査用の自己評価式抑うつ尺度で，20項目から成る．評定は4件法で，得点が高いほど抑うつ状態が強いことを示す（得点範囲0—60点）．ここでの抑うつ状態とは，抑うつ気分の他，悲観的な考え，被害的感情，精神運動抑制などを含む．

関連要因の測定　抑うつに関連する要因として，以下の変数を取り上げた．

1. 基本属性要因：配偶者の有無（0＝配偶者あり（内縁関係を含む），1＝配偶者なし（未婚，別居，離

Table 1
対象者の年齢及び性別の特性

			中年期群（40—59歳）				老年期群（60—79歳）				α[a)]
			男性		女性		男性		女性		
人数		(*n*, %)	564	100.0	552	100.0	551	100.0	544	100.0	
基本属性要因											
配偶者	あり	(*n*, %)	522	92.6	502	90.9	513	93.1	377	69.3	
	なし	(*n*, %)	42	7.4	50	9.1	38	6.9	167	30.7	
身体的要因											
主観的健康感	非常に良い	(*n*, %)	17	3.0	26	4.7	17	3.1	8	1.5	
	良い	(*n*, %)	166	29.4	139	25.2	104	18.9	63	11.6	
	普通	(*n*, %)	336	59.6	344	62.3	351	63.7	398	73.2	
	悪い	(*n*, %)	44	7.8	42	7.6	75	13.6	69	12.7	
	非常に悪い	(*n*, %)	1	0.2	1	0.2	4	0.7	6	1.1	
活動能力	*M*		12.23		12.62		12.23		12.25		.57
	SD		1.17		0.78		1.22		1.19		
心理社会的要因											
老性自覚	なし	(*n*, %)	236	41.8	202	36.6	172	31.2	138	25.4	
	あり	(*n*, %)	328	58.2	350	63.4	379	68.8	406	74.6	
ローカス・オブ・	*M*		27.77		26.00		27.34		25.24		.74
コントロール	*SD*		4.67		4.75		4.70		4.93		
家族外サポート	*M*		28.84		30.39		29.59		30.92		.91
	SD		5.85		5.35		6.07		5.85		
抑うつ	*M*		6.88		7.18		7.39		8.37		.87
	SD		6.5		6.03		7.02		7.28		

a) α＝信頼性係数.

婚，死別を含む)）の2分類とした.

2. 身体的要因：主観的健康感（1＝非常に良い—5＝非常に悪い，の5段階評定）と活動能力を尋ねた. 活動能力の測定には，古谷野・柴田・中里・芳賀・須山（1987）の老研式活動能力指標を用いた. この尺度は地域の中で自立した生活を営むために必要な能力である手段的日常生活動作能力（Instrumental Activities of Daily Living：以下IADL），機能的日常生活動作能力（Functional Activities of Daily Living：以下FADL），及び社会活動性を測定する. 13項目から成り，2件法，13点満点で，高得点ほど活動能力が高いことを示す.

3. 心理的要因：老性自覚の測定は，家族の死や病気などの体験の有無を尋ねるライフイベント・チェックリスト中の1項目として，過去2年間における老いの自覚体験の有無を，1＝あり，0＝なしの2段階で尋ねた. 過去2年間としたのは，NILS-LSAの測定が2年ごとに行われるためである. ローカス・オブ・コントロールの測定には，8項目からなる尺度（若林・蔭山・金井，1995）を用いた. この尺度は5件法で回答を求め，高得点ほど内的統制，低得点ほど外的統制であることを示す（得点範囲8—40点）. ソーシャルサポートの測定には，家族以外の人々からのサポートを測定するソーシャルサポート尺度（浦，1992）を用いた. この尺度は10項目から成り，5件法で，得点が高いほどサポートを受けていることを示す（得点範囲10—50点）. 各尺度の信頼性係数はCronbach α係数を求めて検討した. 各尺度の信頼性係数はTable 1に示した. α係数は，活動能力でやや低かったが，これは中年期のデータがほとんど満点であったためと考えられ，尺度の測定する内容を知る重要度から，今後の分析に用いる必要があると判断した.

測定及び分析方法

老性自覚は，個別面接法によりその有無を測定した. その他の変数は，自記式調査票を用い，自宅で記入した上で面接時に持参するよう依頼し，面接時に再度未記入部分や不明点などを確認した. 面接調査員はすべて調査方法について訓練を受けた臨床心理学専攻の大学院生である.

分析手順としては，まず，対象者を中年期（40—59歳），老年期（60—79歳）の二つの年齢コホート（世

代），及び性別のそれぞれ2群に分割し，各要因における年齢差・性差を検討した．カテゴリー変数の比率の差の検定には年齢・性別に χ^2 検定を用いた．連続変数については年齢×性の2要因分散分析を行った．

次にCES-Dを基準変数とし，関連要因の各変数を説明変数として，F 値の変動が，変数追加では.05，変数削除では.10の確率で起きた場合に変数の追加と削除を行うステップワイズ法による重回帰分析を行い，関連要因相互の影響を取り除いた上で年齢及び性別の4群における抑うつに関連する要因について検討した．統計処理は，すべて統計プログラムパッケージSAS（Ver. 6.12, 1997）を用いた．

結　果

対象者の特徴

分析対象者の年齢及び性別による各特性の値をTable 1に示す．配偶者の有無については，χ^2 検定より年齢・性の頻度の偏りが共に有意で（$\chi^2(1)=52.18$, $p<.001$; $\chi^2(1)=75.75$, $p<.001$），老年期及び女性で配偶者なし（未婚，離婚，死別を含む）の割合が高かった．主観的健康感は，χ^2 検定の結果年齢・性の頻度の偏りが共に有意で（$\chi^2(4)=68.21$, $p<.001$; $\chi^2(4)=12.36$, $p<.05$），特に老年期で“悪い”，“非常に悪い”者が多かった．老性自覚についても，χ^2 検定より，年齢・性の頻度の偏りが共に有意で（$\chi^2(1)=29.53$, $p<.001$; $\chi^2(1)=7.66$, $p<.01$），老年期及び女性で“あり”の者が多かった．また，活動能力は，年齢×性の2要因分散分析を行ったところ，年齢の主効果及び性の主効果が共に有意であり，（$F(1,2\,207)=15.35$, $p<.001$，老年期＜中年期；$F(1,2\,207)=19.74$, $p<.001$，男性＜女性），両条件の交互作用に有意差がみられた（$F(1,2\,207)=15.31$, $p<.001$）．そこで，男性群，女性群それぞれにおける年齢要因の単純主効果を検定したところ，女性群のみ年齢の効果が有意であり（$F(1,1\,094)=37.06$, $p<.001$），中年期の活動能力が高かったが，男性では年齢差がみられなかった．ローカス・オブ・コントロールは，2要因分散分析の結果，年齢の主効果及び性の主効果が共に有意であり，（$F(1,2\,207)=8.65$, $p<.01$，老年期＜中年期；$F(1,2\,207)=91.38$, $p<.001$，女性＜男性），交互作用は見出されなかった．家族以外からのソーシャルサポートは，2要因分散分析の結果年齢の主効果及び性の主効果が共に有意で（$F(1,2\,207)=6.76$, $p<.01$; $F(1,2\,207)=34.22$, $p<.001$），老年期及び女性で高く交互作用は見出されなかった．抑うつについては，2要因分散分析の結果，年齢の主効果及び性の主効果が共に有意であり（$F(1,2\,207)=8.78$, $p<.01$; $F(1,2\,207)=4.92$, $p<.05$），老年期及び女性で高く，交互作用はみられなかった．以上より，すべての要因で年齢・性差がみられたので，以後の分析は，年齢及び性別の4群で行った．

抑うつの関連要因

分析に用いた基準変数及び説明変数の各変数間の相関をピアソンの相関係数により検討したところ，CES-D得点と正の相関がみられた変数は，配偶者（なし），主観的健康感（悪い），老性自覚（あり）であった．負の相関がみられた変数は，活動能力，ローカス・オブ・コントロール，家族以外からのソーシャルサポートであった．CES-D得点とすべての変数間で統計的に有意な相関が示されたが，いずれも相関係数は低かった．また，説明変数間の相互相関についても，弱い関連しかみられなかった．次に，CES-D得点を基準変数とする各群別の重回帰分析によって，抑うつの関連要因について検討した．説明変数として投入した変数は，今回の研究に用いた基本属性要因，身体的要因，心理社会的要因のすべてである．Table 2に示すように，回帰式全体の決定係数（R^2）は，中年期男性群=.211，中年期女性群=.149，老年期男性群=.276，老年期女性群=.184であり，いずれの年齢群においても有意であった（中年男性群：$F=29.81$, $p<.001$，中年女性群：$F=19.11$, $p<.001$，老年期男性群 $F=34.64$, $p<.001$，老年期女性群 $F=20.12$, $p<.001$）．またすべての説明変数間の相関は低く，トレランス値も.78—.99であったため，変数間の多重共線性の問題はないものと判断した．

各投入変数の標準偏回帰係数を観察すると，いずれの群に対してもCES-D得点との有意な関連を示したのは，主観的健康感とローカス・オブ・コントロールであった．つまり，主観的健康感が不良の者，外的統制の者は，年齢・性別にかかわらず抑うつが高いという関係が認められた．（主観的健康感：$\beta=.207$—.263，ローカス・オブ・コントロール：$\beta=-.284$——.188）．配偶者の有無については，中年期群，老年期男性群でCES-D得点に影響し（中年期男性群：$\beta=.100$, $p<.01$，中年期女性群：$\beta=.081$, $p<.05$，老年期男性群：$\beta=.152$, $p<.001$），配偶者なしの者は抑うつが高いことが示されたが，老年期女性群のみ抑うつとの有意な関係が認められなかった．活動能力については，老年期の男女群共にCES-D得点に有意な効果を示し（老年期男性群：$\beta=-.134$, $p<.001$，老年期女性群：$\beta=-.109$, $p<.01$），社会生活や日常生活に支障がある高齢者ほど抑うつを訴えることが多いことが示された．しかし，中年期群では有意な効果はなく，活動能力の程度はCES-D得点に影響しなかった．老性自覚については，女性群のみでCES-D得点に影響し（中年期女性群：$\beta=.083$, $p<.05$，老年期女性群：$\beta=.078$, $p<.05$），老性自覚を持つ女性ほど，抑うつが高くなることが示されたが，男性群では

Table 2
うつを従属変数とする年齢・性別の重回帰分析結果[a)]

	中年期		老年期	
	男性 (n=564)	女性 (n=552)	男性 (n=551)	女性 (n=544)
基本属性要因				
配偶者	.100**	.081*	.152***	.064
身体的要因				
主観的健康感	.222***	.207***	.263***	.231***
活動能力	−.075		−.134***	−.109**
心理社会的要因				
老性自覚		.083*	.056	.078*
ローカス・オブ・コントロール	−.284***	−.203***	−.195***	−.188***
家族外サポート	−.063	−.144***	−.182***	−.104*
R^2	.211	.149	.276	.184
自由度調整済 R^2	.204	.141	.269	.174
F 値	29.81***	19.11***	34.64***	20.12***

[a)] 数値は標準偏回帰係数を示す.
*** p<.001, ** p<.01, * p<.05.

有意な効果がみられなかった．家族以外の人からのソーシャルサポートについては，中年期女性群，老年期群でCES-D得点に影響し（中年期女性群：β=−.144, p < .001，老年期男性群：β=−.182, p < .001，老年期女性群：β=−.104, p<.05），家族以外の周囲の人々からソーシャルサポートを受けている者ほど，抑うつが低いという関係がみられた．しかし，中年期男性群では有意な関連がみられなかった．

考　察

本研究では，40歳から79歳の地域住民に対し，中年期群，老年期群の年齢コホート2群，及び性別群の合計4群について，各群における抑うつに影響する要因の違いを明らかにし，その上で老年期の特徴を検討した．各群において，それぞれ特徴的な抑うつとの関係が示された．

まず，基本的な属性である配偶者の有無については，川本他（1999）やZung et al.（1993）は，配偶者を持たない人の抑うつ得点が高いことを指摘している．今回の結果では，配偶者の有無について，老年期女性群のみ抑うつとの有意な関係が認められなかった．老年期男性は，配偶者との死別や離婚が，心理的喪失体験となり，抑うつを伴うという報告があるが（Pahkala, 1990），老年期では配偶者に対する心理的依存度が，男女間で異なるのかもしれない．また，今回の結果からは，死別と未婚や離婚，別居の違いまでは分からないが，“配偶者なし”の内容が年齢や性別で異なる可能性がある．例えば，中年期には未婚・離婚の割合が高いが，老年期は死別の割合が高くなるであろう．そのため，今後は，それらの違いを含めた検討が必要である．

身体的側面と抑うつとの関連については，すべての年齢群において，主観的健康感と抑うつとの関連が強かった．つまり年齢や性にかかわらず，身体的に健康であるか否かが抑うつ状態に強く関与することが確認され，これまでの研究結果とも一致した．しかし，今回は，身体的な健康状態を測定する一つの指標として主観的健康感を変数として投入したものの，主観的健康感は，実際の健康さより，むしろ自己の健康面をどのようにとらえるかといった主観的なものである．また，CES-Dには身体的症状に関する項目がいくつか含まれている．そのため，主観的健康感と抑うつとの関連がみられたとも考えられる．従って，主観的健康感は，ある程度客観的な健康状態を反映し，その状態を把握するための一つの簡便な方法であるとする報告は多くあるが（芳賀・上野・永井・須山・安村・柴田・松崎・古谷野，1988; McGee, Liao, Cao, & Cooper, 1999），抑うつとの関連を検討するには，客観的な身体変数を用いるべきであったかもしれない．身体疾患と抑うつのかかわりを指摘した報告は多いため（Barusch et al., 1999; Black, Markides, & Miller, 1998; Meeks, Murrell, & Mehl, 2000），今後は，現病歴や慢性疾患の有無といったより客観的な変数を含め，抑うつとの関連を検討する必要がある．

次に，高齢者の場合，身体機能の低い者に抑うつ症状が生じやすいことが，多くの先行研究で報告されて

いる（Barusch et al., 1999；井原，1993；村岡他，1996）．井原（1993），村岡他（1996）は，高齢期における抑うつ状態と日常生活動作能力（Activities of Daily Living：以下ADL），またはIADLの関連について指摘しているが，今回も同様に老年期群で抑うつ状態との強い関連が認められた．今回は，食事・排泄などの基本的なADLではなく，社会生活や日常生活上で自立した生活を行う場合に必要な活動能力を測定したが，この能力に日常的な制限がある場合，うつ症状を多く訴える傾向が示された．このことから，高齢者にとって基本的な生活能力だけでなく，地域での独立した社会的な活動性が，心理的な健康に強く関連することが明らかとなった．身体的自立の低下はもちろんのこと，日常的な社会生活を送る上で支障となるような障害についても，高齢者の場合は特に配慮する必要があるだろう．

心理社会的変数のうち，まず，老性自覚と抑うつとの関連については，今回の結果では，女性群のみで，抑うつへの有意な効果を示した．女性の方が男性よりも老いに対して否定的な態度を抱きやすいという(Linn & Hunter, 1979)．これは，女性としての価値を若々しさに求めがちな社会的風潮が影響していると考えられる．今回の結果からは，Baum & Boxley (1983) が指摘するように，高齢者ほど老性自覚と抑うつとの関連が強いという点までは説明できなかった．中年期も老年期も，老いの自覚を機に，自分の人生に残された時間がどれだけあるかについて考え始め，様々な自己の変化を認識し，自己限界に気づきながらも，一方でそれを認めたくないという自己内の葛藤が起こりやすく，抑うつ状態になりやすいと考えられるが，その体験内容と抑うつとの関係は，中年期と，老年期では異なる可能性がある．例えば，中年期の女性は，閉経を初め，顕著な内分泌系・生理的な加齢現象が起こり，身体的・生理的な喪失を体験しやすく，それに伴い抑うつ状態が生じる場合が観察される．一方，老年期では，家族や友人の死亡，退職などの社会的な面で様々な喪失を体験する機会がより多くなるであろう．従って今後の詳細な検討が課題として残された．

次に，個人的な帰属スタイルの一つであるローカス・オブ・コントロールは，いずれの年齢群においても抑うつと強く関連した．老年期になると，内的統制力の低下により，抑うつ症状が強まるという説もあるが（Linn & Hunter, 1979），今回の結果からは抑うつとの関係に年齢及び性差は見出されなかった．このことから，老年期に限らず，外的統制であることは，抑うつに関連することが示唆された．内的統制の人は人生上の出来事はすべて自分の采配によると信じており，運命や偶然によって決められると信じている人よりも，ストレスに効果的に対処することができるため(Krause, 1987)，抑うつ状態にもなりにくいのかもしれない．また逆に，Hoffart & Torgersen (1991) がうつ病の患者は悪い出来事の原因を外在化する傾向があることを報告しているように，抑うつ状態が外的統制に影響する場合も考えられる．

更に，ソーシャルサポートと抑うつとの関連は，これまで多くの研究により報告されている（Antonucci, Fuhrer, & Dartigues, 1997；川本他，1999; Oxman & Hull, 1997）．今回の結果においても，ソーシャルサポートを受けていることと抑うつ状態が低いことは関連することが明らかとなり，これまでの結果と一致した．従来，わが国の高齢者のソーシャルサポート及びサポートネットワークは，他の世代と同様に，夫婦・親子関係を軸として考えられてきた．しかし，中年後期から老年期において，死別や別居などにより家族形態が縮小するため，加齢と共に自分を支援してくれる家族数は自ずと小さくなる（Antonucci & Akiyama, 1987）．ネットワーク構成が変化する中で，高齢者が精神的健康を維持していくためには，家族以外の人々からの社会的支援の必要性が大きくなり，それに伴い家族以外の人々からのサポートが個人の心理面に与える影響度も大きくなるのではないだろうか．従って，今回の研究では，ソーシャルサポート尺度として，家族以外の周囲の人々から受けたサポートの程度を尋ねる尺度を用いた．その結果，老年期群において，ソーシャルサポートと抑うつの間に有意な関係が示された．家族などから支援を得ることが難しい高齢者の場合は，医師や保健婦，ヘルパーなどによるフォーマルなサポート体制を整備充実させていくことが，高齢者自身の精神的健康の維持にもつながるといえよう．一方，中年期男性群で，今回抑うつとの関連がみられなかったのは，この時期の男性の場合，親密な人間関係はやはり夫婦や家族を中心としたものであるため，今回の家族以外からのサポートには反映されなかったと考えられる．このように，サポートを提供するネットワークの構造と機能は，年齢や性別によって異なり，抑うつとサポートとの関係を検討する際には，これらの側面を考慮する必要がある．

以上，地域在住の中年期から老年期の男女の抑うつに関連する要因について検討したところ，主観的健康感の低さ，ローカス・オブ・コントロール（外的統制）がいずれの群でも抑うつと強く関連した．一方，各群で独自の抑うつに影響する要因が示され，老年期の抑うつの背景要因として，活動能力や家族以外からのソーシャルサポート，女性では中年期老年期共に，老性自覚が重要であることが示された．地域住民の生活の質（Quality of Life: QOL）を維持向上させていくためには，これらの背景因子の改善を含めた抑うつ予防の方策を，年齢や性の違いを考慮した上で検討していく必要がある．ただし，本研究は横断研究である

ため，今回の結果からは，抑うつと関連がみられた変数との間の因果関係までは不明である．そのため，今後縦断研究の結果の分析に期待される．

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The relationship between intraocular pressure and refractive error adjusting for age and central corneal thickness

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Abstract

Purpose: To investigate the relationship between intraocular pressure (IOP) and refractive errors after adjusting for age, central corneal thickness (CCT), and other related factors.

Methods: IOP, CCT and refractive errors were measured in the right eyes of 1855 subjects, aged 40–82 years, in a cross-sectional study design. Subjects were divided into groups by refractive status: hyperopia, emmetropia, mild myopia, moderate myopia, or high myopia. With adjustments for age, CCT, blood pressure, obesity, education, hypertension, diabetes, and smoking status, IOP was estimated for each refractive status using a general linear model.

Results: IOP increased with advancing degrees of myopia, even after adjustment for age, CCT, and other related factors ($p = 0.011$). Estimated IOP of moderate myopia was significantly higher than that of emmetropia ($p = 0.022$).

Conclusions: Our results confirm the positive association between IOP and increasing degrees of myopia. This finding would support the hypothesis that the relationship between glaucoma and myopia might be pressure mediated.

Keywords: central corneal thickness, epidemiological study, intraocular pressure, refractive error

Introduction

It is generally accepted that there is an increased prevalence of glaucoma among myopic eyes (Perkins and Phelps, 1982). In fact, two recent population-based studies demonstrated that myopic eyes had a 1.6 to 3.3 times increased risk of glaucoma (Mitchell *et al.*, 1999; Wong *et al.*, 2003). One of the reasons as to why glaucoma should be more frequent in myopic eyes seems to be higher intraocular pressure (IOP) in myopic eyes compared with non-myopic eyes (David *et al.*, 1985; Klein *et al.*, 1992; Mitchell *et al.*, 1999; Wong *et al.*, 2003). This causal relationship can be rationalised by the knowledge that IOP is still considered an important risk factor for the development of glaucoma (Racette *et al.*, 2003). The Visual Impairment Project in Australia showed that the mean IOP among patients with newly developed glaucoma over a 5-year period was significantly higher than that among the non-incident cases (Mukesh *et al.*, 2002). Furthermore, it has been suggested that myopic eyes are more susceptible to the effects of elevated IOP (Perkins and Phelps, 1982). It has been also proposed that myopic eyes have abnormal connective tissue that could predispose to glaucoma (Fong *et al.*, 1990).

There is evidence from the literature that a correlation exists between refractive status and IOP (David *et al.*, 1985; Klein *et al.*, 1992; Mitchell *et al.*, 1999; Wong *et al.*, 2003). Even after adjusting for age, sex, diabetes and blood pressure, mean IOP was approximately 0.5 mmHg higher in myopic eyes compared with non-myopic eyes in the Blue Mountains Eye Study (Mitchell

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et al., 1999). However, little is known about the true relationship between refractive status and IOP taking into account the central corneal thickness (CCT), as the CCT has a significant influence on IOP measurement. It has been reported that thinner corneas result in artificially lower IOP readings and that thicker corneas cause artificially high IOP readings (Ehlers *et al.*, 1975; Whitacre and Stein, 1993; Herndon *et al.*, 1997; Doughty *et al.*, 2002). Furthermore, our previous report showed that the influence of CCT on IOP measurement was greater than those of age, blood pressure, or obesity (Nomura *et al.*, 2002). Therefore, investigation of the relationship between refractive status and IOP after adjusting for CCT would be required. In the present study, we aimed to clarify the true relationship in a community-dwelling Japanese population.

Materials and methods

Data for the present study came from the National Institute for Longevity Sciences – the Longitudinal Study of Aging programme (NILS-LSA), a population-based survey of ageing conducted in Obu-shi and Higashiura-cho, Aichi prefecture, Japan, from April 2000 to May 2002. The subjects were randomly selected from a community-dwelling population stratified by age and gender. Their ages ranged from 40 to 82 years. A detailed description of the sampling scheme has been reported elsewhere (Shimokata *et al.*, 2000). The eye examinations were performed by two trained medical practitioners, subjected to periodical quality control, using the same instruments throughout the examination period. The Ethical Committee of the Chubu National Hospital reviewed all procedures for the study, and written informed consent was obtained from all subjects.

In the period, 2259 individuals participated in the NILS-LSA. Of these, those with a history of eye surgery (104 persons), current users of contact lenses (83 persons), or current users of ophthalmic therapy for glaucoma (100 persons) were excluded from the present study. In the present study, we assessed the right eyes of 1855 subjects (996 men and 859 women), because the data of IOP (five persons), refractive errors (37 persons), or CCT (95 persons) was missing.

IOP was measured three times with a non-contact tonometer (NT-3000; Nidek, Gamagori, Japan) between 09.00 and 12.00 hours, and the mean value of the three measurements was used for analysis. CCT was measured with a Topcon specular microscope (SP-2000P; Topcon, Tokyo, Japan). Refractive error data were obtained using an automatic refractor, ARK700A (Nidek), with subjective refinements for each participant. The spherical equivalent (sphere + 1/2 cylinder) was used to calculate the refractive error. Participants were divided into five groups according to refractive status: hyperopia, emmetropia, mild myopia, moderate myopia and high myopia.

Height and weight were measured according to a standardised protocol, and body mass index was calculated by dividing weight (in kilograms) by height squared (in metres). Systolic and diastolic blood pressures were measured with a standard mercury sphygmomanometer on the right arm between 09.00 and 12.00 hours. Information on the smoking status, years of education, and history of hypertension and diabetes was also recorded using a self-administered questionnaire.

All statistical analyses were performed using the Statistical Analysis System (SAS Institute, Cary, NC, USA) release 6.12. In each refractive group, mean values of age, CCT, and IOP were calculated. As only seven people were classified with high myopia, no further analysis was performed on this group. First, in univariate manner, the relationships between IOP and the related factors were assessed using correlation analyses or Student's *t*-tests. Subsequently, using a general linear model (PROC GLM), the least square mean values for IOP in each refractive group were determined (LSMEANS statement) after adjusting for age, CCT, systolic blood pressure, body mass index, years of education, history of hypertension and diabetes, and smoking status (as these factors seem to be related to IOP value or refractive error). Differences in the estimated IOP with the refractive status were tested using the Tukey multiple comparison method (ADJUST option) and the trend in refractive status difference was also tested using the CONTRAST option of the PROC GLM. In the present analyses, age, CCT, IOP, blood pressure, body mass index and years of education were entered as continuous variables.

Results

Table 1 shows the characteristics of the subjects. IOP value significantly positively correlated with the value of CCT, systolic blood pressure, diastolic blood pressure, body mass index and years of education ($p < 0.0001$). IOP had a significant inverse correlation with age and refractive error ($p < 0.0001$). The mean IOP value of those with hypertension was significantly higher than that of those without hypertension (Student's *t*-tests, $p = 0.003$), or diabetes (Student's *t*-tests, $p = 0.0002$). There was no significant difference in IOP value between current smokers and past or non-smokers. When compared with the included subjects using Student's *t*-tests, those excluded were older (mean: 63.7 years, $p < 0.0001$), and had low IOP value (mean: 12.6 mmHg, $p = 0.002$), myopic eye (mean: −1.30 dioptres, $p < 0.0001$), thinner CCT (mean: 511 μm, $p = 0.014$), higher systolic blood pressure (mean: 124.5 mmHg, $p = 0.005$), and were less educated (mean: 11.3 years, $p < 0.0001$).

Table 1. Characteristics of subjects (n = 1855)

Characteristics	Mean	S.D.
Age (years)	58.9	10.9
Intraocular pressure (mmHg)	13.0	2.6
Refractive errors (dioptres)	−0.61	1.35
Central corneal thickness (μm)	516	33
Systolic blood pressure (mmHg)	121.6	18.9
Diastolic blood pressure (mmHg)	74.6	11.1
Body mass index (kg m^{-2})	23.0	3.0
Years of education (years)	11.9	2.8
	N	%
History of hypertension	472	25.4
History of diabetes	141	7.6
Smoking status		
Non-smoker	996	53.8
Past smoker	448	24.2
Current smoker	407	22.0

As shown in the *Table 2*, the mean IOP value of the moderate myopia group was significantly higher than those of the hyperopia ($p < 0.0001$), emmetropia ($p < 0.0001$), or mild myopia ($p = 0.004$) groups. The mean IOP value of the mild myopia group was also significantly higher than that of the hyperopia group ($p = 0.012$). Similarly, the CCT value of the moderate myopia group was significantly higher than the CCT value from the hyperopia ($p = 0.003$), emmetropia ($p = 0.032$), or mild myopia ($p = 0.020$) groups. Even after adjustment for the related factors (age, gender, CCT, systolic blood pressure, body mass index, years of education, history of hypertension and diabetes, and smoking status), there was a significant trend of increasing IOP with increasing degrees of myopia ($p = 0.011$). The estimated IOP value for moderate myopia was significantly higher than the emmetropia values ($p = 0.022$).

Discussion

There have been several reports of a positive correlation between IOP and increasing degrees of myopia (David *et al.*, 1985; Klein *et al.*, 1992; Mitchell *et al.*, 1999; Wong *et al.*, 2003). Nevertheless, it has also been reported that no difference in IOP was detected between the two eyes in anisometropic subjects with unilateral high myopia (Bonomi *et al.*, 1982). Therefore, the relationship between IOP and myopia has been inconclusive. However, little or no evidence considering the influence of CCT on this relationship has been reported, although the influence of CCT on IOP measurement seems critical. The data reported here show that there is a positive significant association between IOP and advancing degrees of myopia, even after adjusting for age, CCT, and other relevant factors.

It is unclear why people with myopia are found to have higher IOPs than those with hyperopia or emmetropia. David *et al.* (1985) investigated the relationships between IOP and other factors using analysis of variance and reported that mean IOP values were associated with age, refractive status, country of birth and interaction between refractive status and country of birth. They suggested that there was a complex relationship between IOP and refractive status.

It has also been reported that IOP in children, as in the adult population, may be higher in myopic than non-myopic eyes (Quinn *et al.*, 1995). It has been controversial whether high IOP could contribute to

Table 2. Comparison of age, central corneal thickness, and intraocular pressure according to refractive status

Refractive status	No. of subjects	Mean (S.E.)			Estimated IOP value (S.E.) adjusted for related factors[1]
		Age (years)	CCT (μm)	IOP (mmHg)	
Hyperopia	284	67.8 (0.6)	512.5 (1.9)	12.6 (0.2)	13.1 (0.2)
Emmetropia	764	60.2 (0.4)	516.0 (1.2)	12.9 (0.1)	13.1 (0.1)
Mild myopia	673	54.9 (0.4)	515.4 (1.3)	13.1 (0.1)	13.3 (0.1)
Moderate myopia	127	52.8 (0.9)	525.0 (2.9)	14.0 (0.2)	13.7 (0.2)
High myopia	7	58.4 (3.8)	520.6 (12.3)	13.2 (1.0)	N/A
p Value for trend[2]		<0.0001	0.0007	<0.0001	0.011

IOP, intraocular pressure; CCT, central corneal thickness; S.E., standard errors; N/A, not applicable.

[1] Related factors consist of age, CCT, systolic blood pressure, body mass index, years of education, history of hypertension and diabetes, and smoking status.

[2] p Values for trend were calculated after the exclusion of those with high myopia.

Hyperopia: spherical equivalent greater than +0.5 D.

Emmetropia: spherical equivalent ≤+0.5 D and >−0.5 D.

Mild myopia: spherical equivalent ≥−0.5 D and <−3 D.

Moderate myopia: spherical equivalent ≥−3 D and <−6.0 D.

High myopia: spherical equivalent ≥−6.0 D.

axial elongation and myopia in children. However, a recent prospective study indicated that a high IOP follows the onset of myopia and cannot cause myopia (Edwards and Brown, 1996), which would imply that myopic eyes have a peculiar mechanism causing high IOP.

There are some limitations in the present study. A non-contact tonometer is used to measure IOP, which should give a wider variation in the IOP measurement values than the Goldmann applanation tonometer (Mackie *et al.*, 1996). However, in many studies, comparisons with Goldmann applanation indicate that the non-contact tonometer is reliable within the normal IOP range (Forbes *et al.*, 1974; Koopmans *et al.*, 1991; Cho and Lui, 1997; Katsushima *et al.*, 2002). In particular, it has been reported that the Nidek non-contact tonometer produces repeatable IOP readings and is comparable with the Goldmann applanation tonometer (Cho and Lui, 1997). We were also unable to assess the lens status. Previous population-based surveys demonstrated that nuclear sclerosis of the lens was associated with high IOP (Klein *et al.*, 1992), and that myopia was found to be greater in people with higher degrees of nuclear opacity (Wensor *et al.*, 1999), We cannot exclude the possibility that nuclear sclerosis or opacity is responsible for the relationship between IOP and myopia, although the participants of NILS-LSA should be subject to nuclear sclerosis or opacity of the lens commensurate with their age range. In addition, a number of people excluded in the present study, such as those with a history of eye surgery and current contact lens users, may influence our findings. Cataract surgery should influence the IOP value and the refractive errors of the subjects (Cekic *et al.*, 1998; Dimitrov *et al.*, 2001), and epithelial oedema caused by contact lens wearing should lead to the overestimate of corneal thickness (Whitacre and Stein, 1993). Therefore, some differences between those individuals included and excluded in the present study seems to be inevitable.

Further work including assessment of the lens will be necessary to distinguish the relationship. However, it is noteworthy that mean IOP in myopic eyes is higher compared with non-myopic eyes after adjusting for age and CCT. This finding supports the hypothesis that the relationship between glaucoma and myopia might be pressure mediated.

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CLINICAL INVESTIGATION

Visual Acuity in a Community-dwelling Japanese Population and Factors Associated with Visual Impairment

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Abstract

Purpose: The aim of this study was to describe the distribution of visual acuity and investigate the predictors of visual impairment in a Japanese population.

Methods: Best-corrected visual acuity was measured in 2263 subjects aged 40–79 years randomly selected from a local community. Relations between visual impairment and possible risk factors were investigated.

Results: Among these subjects, 41 individuals (1.8%) were identified as visually impaired (best-corrected visual acuity in the better eye <0.5). Both sexes in the older age groups had a higher frequency of visual impairment (Mantel-Haenszel chi-square test: $P < 0.001$). A multiple logistic regression indicated that an increase in age of 10 years [odds ratio (OR) 3.9; 95% confidence interval (CI) 2.3–6.7] and myopia (OR 2.9; 95%CI 1.4–6.0) were independent risk factors for visual impairment. Individuals with the highest level of education (college or higher) had a lower risk of visual impairment (OR 0.1; 95%CI 0–0.7) compared to individuals with the lowest level of education.

Conclusions: As expected, visual impairment increased with advancing age, although the prevalence of visual impairment in our population was lower than in other surveys. Racial and regional differences and differences in study design may be responsible for discrepancies between surveys. It is noteworthy that myopia was a significant risk factor for visual impairment, although the reasons for this association are uncertain and need further investigation. **Jpn J Ophthalmol** 2004;48:37–43 © Japanese Ophthalmological Society 2004

Key Words: Japanese population, population-based survey, visual acuity, visual impairment

Introduction

The populations of many countries around the world are aging, and the proportion of the elderly is increasing rapidly. This may be especially important for Japan because the average life span for the Japanese is longer than for other nationalities. It is generally accepted that vision, like other functions, declines with age,[1–15] so it is conceivable that many elderly people live with vision disabilities. Adequate vision is essential for maintaining independence in the lives of the elderly. According to a report from the Ministry of Health and Welfare in 1996, more than 300000 people in Japan had visual handicaps and 45.2% of them were 70 years of age or older.[16] This rate had increased from 41.6%

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in 1991.[17] For planning health services or for risk factor analysis, it is necessary to know the magnitude and distribution of visual impairment and blindness in a community-dwelling population. To our knowledge, however, there has been no population-based analysis of visual acuity among Japanese adults.

This is the first report on visual acuity in a community-dwelling, middle-aged to elderly population in Japan. In addition, we present the age-specific and sex-specific prevalence of visual impairment as assessed by visual acuity measurements and investigate its risk factors using data from the National Institute for Longevity Sciences–Longitudinal Study of Aging (NILS-LSA).

Subjects and Methods

Data for this report come from the NILS-LSA, a population-based survey of aging conducted in Obu-shi and Higashiura-cho, Aichi Prefecture, Japan. Random sampling from the municipal register, which was stratified by age and sex, identified noninstitutionalized eligible subjects from the same racial and ethnic origins, aged 40–79 years. Details about the methodology used in this survey have been reported elsewhere.[18] In brief, the NILS-LSA report consists of clinical evaluations, body composition and anthropometry, physical function, nutritional analysis, and psychological tests. At the research center, participants were interviewed regarding demographic characteristics, medical and ophthalmologic history, and self-reported vision problems. The Ethics Committee of the Chubu National Hospital reviewed all procedures for the study, and written informed consent was obtained from all subjects.

This research area is geographically located at the center of Japan, and the climate is generally average for Japan. We examined how representative the area is via a national postal questionnaire sent to 3000 households from all the prefectures in Japan and found that the lifestyle in this area was the most typical of all areas in Japan. Therefore, it was thought that the results of examinations in this area would be representative of the entire population of Japan.[19]

In the present study, we analyzed the baseline data of NILS-LSA obtained from November 1997 to April 2000. A total of 7790 eligible subjects were identified during recruitment, and 3430 people responded to the request for participation. Of this group, 2267 individuals (66.1%) participated in the NILS-LSA. In the present study, only 2263 subjects (29.1% of those eligible) (1134 men, 1129 women) were evaluated (the visual acuity data were missing for four people).

As part of the standardized examination, automatic objective refraction evaluation with the ARK700A (NIDEK, Gamagori, Japan) was carried out on each participant. Visual acuity was then measured in each eye with the Landolt broken ring chart at 5 m under standard lighting conditions and assessed initially using any corrective devices the participant was currently using. If the participant was unable to read the chart at the 1.0 equivalent line in either eye, refraction was determined using the results of the objective refraction as a starting point. The best-corrected visual acuity was defined as the visual acuity after subjective refinement of refraction in the participant's better eye, and both the derived refraction data and the visual acuity were recorded. When the presenting acuity of the participant was 1.0 or better, the initial objective refraction result was recorded as the participant's refraction data. The spherical equivalent (sphere + $^1/_2$ cylinder) was used for calculations of refractive error. Myopia was defined as the spherical equivalent of −0.5 diopter (D) or less. Because of the age of our study population, no cycloplegia was used.

We used both the World Health Organization (WHO) criteria and the United States (U.S.) criteria for visual impairment in the present study. With the WHO criteria,[20] *blindness* is defined as a best-corrected visual acuity of <0.05 in the better eye and *low vision* as a best-corrected visual acuity of <0.3 but ≥0.05 in the better eye. *Visual impairment* is defined as a best-corrected visual acuity of <0.3 in the better eye. With the U.S. criteria,[3,10,13] *blindness* is defined as a best-corrected visual acuity of ≤0.1 in the better eye and *low vision* as a best-corrected visual acuity of <0.5 but >0.1 in the better eye. *Visual impairment* is defined as a best-corrected visual acuity of <0.5 in the better eye.

Information on household income, education level, and history of diabetes, hypertension, and cataract surgery was obtained from questionnaires filled out by the participants. Cataract surgery was defined as a history of cataract surgery in the participant's better eye. We grouped household income and education level into three categories each.

For analysis, the exact Mantel-Haenszel chi-square test and multiple logistic regressions were used to assess the relations between visual impairment and other potential risk factors: age, sex, household income, education level, myopia, diabetes, hypertension, history of cataract surgery. Data were analyzed using the Statistical Analysis System (SAS), release 6.12.[21]

Results

The 2263 participants in our study underwent visual acuity measurements at the NILS-LSA center. The mean age of the participants was 59.2 years. Distribution of the best-corrected visual acuity is shown in Table 1. Using the WHO criteria only 10 individuals (0.44%) were identified as being visually impaired (2 with blindness, 8 with low vision), whereas with the U.S. criteria we identified 41 individuals (1.81%) who were visually impaired (4 with blindness, 37 with low vision). If the WHO criteria had been used, the number of the participants classified as visually impaired would have been too small to analyze. We therefore used the U.S. criteria for visual impairment in the following analyses.

There were four age groups: 40–49, 50–59, 60–69, and 70–79 years. There was no significant difference between

Table 1. Percentage distribution of best-corrected visual acuity in the better eye, by age and sex

		Visual acuity						
		According to WHO criteria			According to U.S. criteria			
Age (years)	No.	<0.05	0.05 to <0.3	0.3 to <1.0	−0.1	>0.1 to <0.5	0.5 to <1.0	1.0+
Men								
40–49	289	0	0	5.54	0	0	5.54	94.46
50–59	283	0.35	0.35	10.65	0.35	0.71	10.60	88.34
60–69	287	0	0	25.09	0	0.35	24.74	74.91
70–79	275	0	1.09	42.91	0.36	4.73	38.91	56.00
Total	1134	0.09	0.35	20.90	0.18	1.41	19.75	78.66
Women								
40–49	280	0	0	3.21	0	0	3.21	96.79
50–59	284	0	0	10.90	0	0	10.92	89.08
60–69	283	0	0.35	29.33	0.35	1.77	27.56	70.32
70–79	282	0.35	1.06	52.13	0.35	5.67	47.52	46.45
Total	1129	0.09	0.35	23.91	0.18	1.86	22.32	75.64
All								
40–49	569	0	0	4.39	0	0	4.39	95.61
50–59	567	0.18	0.18	10.93	0.18	0.35	10.76	88.71
60–69	570	0	0.18	27.19	0.18	1.05	26.14	72.63
70–79	557	0.18	1.08	47.58	0.36	5.21	43.27	51.17
Total	2263	0.09	0.35	22.40	0.18	1.63	21.03	77.15

WHO, World Health Organization; U.S., United States.

Table 2. General and clinical characteristics of subjects with visual impairment

Characteristic	Blindness (n = 4)	Low vision (n = 37)	Visual acuity ≥0.5 (n = 2222)
Age (years)			
Mean	66.5	71.6	59.0
SD	10.7	7.0	10.9
Women (%)	50.0	56.8	49.8
Myopia (%)[a]	50.0	41.2	37.1
History of diabetes (%)[b]	0	16.2	7.1
History of hypertension (%)[c]	25.0	51.4	25.2
History of cataract surgery (%)	50.0	8.1	3.4
Education level (%)[d]			
1	75.0	56.8	32.5
2	25.0	40.5	40.2
3	0	2.7	27.2
Household income (%)[e]			
1	66.7	76.5	41.6
2	33.3	14.7	31.5
3	0	8.8	26.9

[a–e]The data for [a]17 people, [b]11 people, [c]7 people, [d]8 people, and [e]84 people were missing.

Definitions: blindness, best-corrected visual acuity of ≤0.1 in the better eye; low vision, best-corrected visual acuity of <0.5 but >0.1 in the better eye; myopia, spherical equivalent of −0.5 diopter or less.

Education level: 1, elementary school or junior high school; 2, high school; 3, college or university or higher.

Household income: 1, less than 6.5 million yen; 2, 6.5 million to 10.0 million yen; 3, more than 10.0 million yen.

sexes within any age group in terms of the distribution of best-corrected visual acuity. Both sexes in the older age groups had higher frequencies of visual impairment (exact Mantel-Haenszel chi-square test, $P < 0.001$). Among those 40–49 years of age, none of the participants had visual impairment. In contrast, 5.57% of those 70–79 years old were classified as visually impaired. In our total population 77% had good visual acuity (≥1.0), and even at 70–79 years of age about 50% of the subjects had a best-corrected visual acuity of ≥1.0.

Table 2 shows the general and clinical characteristics of visually impaired subjects compared to those with no visual impairment. Visually impaired participants were of a significantly higher mean age (71.1 years) than those with no

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Table 3. Results of multiple logistic regression for risk of visual impairment (n = 2159)

Variable	OR	95%CI
Age (10 years)	3.91	2.28–6.70
Sex (female = 1)	1.14	0.58–2.27
Myopia	2.92	1.42–5.99
Education level		
1	1.00	
2	0.98	0.48–1.98
3	0.10	0.01–0.74
Household income		
1	1.00	
2	0.73	0.29–1.87
3	0.44	0.13–1.53
History of diabetes	1.24	0.48–3.20
History of hypertension	1.34	0.68–2.68
History of cataract surgery	0.99	0.33–2.97

OR, odds ratio; CI, confidence interval.

visual impairment (59.0 years) (Student's t-test, $P < 0.001$). There was a significantly higher frequency of visual impairment when there was a history of hypertension or cataract surgery (chi-square test, $P < 0.001$ and $P = 0.003$, respectively). There was a significantly higher frequency of visual impairment when participants had either a lower education level or a lower household income (Cochran-Mantel- Haenszel test, $P < 0.001$). No significant association was found between the frequency of visual impairment and sex, myopia, or history of diabetes.

Table 3 summarizes the results of a multiple logistic regression analysis for risk of visual impairment in the NILS-LSA population. A 10-year increase in age was associated with a 3.91 (95% CI 2.28–6.70) higher probability of having visual impairment. The presence of myopia was associated with a higher prevalence of visual impairment (OR 2.92; 95%CI 1.42–5.99). Those who completed college or more were at lower risk for visual impairment (OR 0.10; 95%CI 0.01–0.74) compared with the least educated group. Sex, household income, diabetes, hypertension, and cataract surgery did not have a significant influence on the risk of visual impairment.

Discussion

This is the first survey to report the prevalence of visual impairment and its risk factors among community-dwelling Japanese adults. According to the U.S. criteria, of the 2263 participants in this study aged 40–79 years only 4 people (0.18%) were classified as being blind and 37 (1.63%) were classified as having low vision. Many of those with visual impairment (75.6%) were in the oldest age group. Using the multiple logistic regression analysis, we also demonstrated that increasing age and the presence of myopia were independent risk factors for visual impairment. In contrast, being highly educated had an independent inverse association with visual impairment. Remarkably, 77.2% of the NILS-LSA participants had good visual acuity (≥1.0). Even in the 70- to 79-year old group, 51.2% of the participants had good acuity.

Table 4 summarizes the visual impairment rates from previous studies. Based on the WHO criteria, all studies have reported that the rates of blindness are less than 1%, except in Barbados black and mixed populations. The rates of low vision are 3% or less, except in Barbados black and Salisbury black populations. The Barbados study,[6] however, adopted the pinhole correction method instead of subjective refraction, which would overestimate the visual impairment rates. Among Asian countries, the Andhra Pradesh Eye Disease Study[14] described the best-corrected visual acuity in an Indian population and showed that 3.9% of those 60–69 years old and 6.2% of those over age 70 had visual impairment. Michon et al. reported that 0.5% of the elderly population (≥60 years old) were blind in Hong Kong.[12] The Malaysian National Eye Survey[11] showed that 2.7% of the whole population (0–96 years old) had visual impairment. As for the elderly population, the rates of blindness and low vision were 0.7% and 4.8%, respectively, among those 60–69 years old and 12.3% and 30.6%, respectively, for those 70 years or older. However, these two surveys also adopted the pinhole correction method instead of using subjective refraction. In Japan, there has been no previous study for visual impairment among community-dwelling, elderly populations. In the institutionalized, elderly population, it has been reported that blindness (visual acuity <0.1) is apparent in 3.4% of those 65–69 years old, 7.4% of those 70–74 years old, 9.7% of those 75–79 years old, and 10.8% of those 80–84 years old.[22] Ichikawa measured visual acuity of outpatients at his hospital, and reported that, on average, it showed a linear decrease with advancing age starting at 45 years of age.[23]

Compared with the above population-based study, the NILS-LSA population, as well as the populations studied in the Visual Impairment Project[9] and the Proyecto Vision Evaluation and Research Project, had low visual impairment rates.[13] One of the likely reasons is racial differences. It is known that visual impairment occurs more frequently in black populations than in white populations, as shown in Table 4. Comparisons between Asian and other populations have not been reported previously. Regional differences can also account for different frequencies of visual impairment, as sunlight exposure is a risk factor in the development of cataracts.[24]

Another reason for the low visual impairment rate in our results could be the age range of our population. Many studies[3–15] have indicated that visual impairment was more frequent in the elderly, especially those over 75 years of age, as the prevalence of age-related eye disorders, such as age-related macular degeneration, cataract, and glaucoma increases with advancing age. Our results showed that the prevalence of visual impairment was strikingly higher in the 70- to 79-year-old group than in the other age groups. The NILS-LSA evaluates the participants longitudinally; therefore, we invited participants under 80 years old to participate in the baseline examination of the NILS-LSA. However, the lower visual impairment rate of our study

Table 4. Comparison of NILS-LSA and other population-based studies on visual impairment

Study name	Study year	Country	Age (years)	Sample size	Race	WHO criteria Low vision (%)	WHO criteria Blindness (%)	US criteria Low vision (%)	US criteria Blindness (%)	Sex difference
NILS-LSA	1997–2000	Japan	40–79	2263	Asian	0.4	0.1	1.6	0.2	No
Baltimore Eye Survey[3,a]	1985–1988	U.S.	40+	2911	White	1.3	0.5	2.7	0.9	No
				2389	Black	1.9	0.9	3.3	1.6	
Beaver Dam Eye Study[5,b]	1988–1990	U.S.	43–86	4926	White	N/A	N/A	4.7	0.5	Yes
Barbados Eye Study[6,a]	1988–1992	Barbados	40–84	4314	Black	5.9	1.7	8.9	3.0	No
				184	Mixed	2.7	1.6	5.4	2.2	
				133	White	3.0	0.0	6.0	0.8	
Rotterdam Study[7,b]	1990–1993	The Netherlands	55–106	6775	White	1.4	0.5	3.8	0.8	No
Blue Mountains Eye Study[8]	1992–1993	Australia	49–97	3647	White	N/A	N/A	4.0	0.7	Yes
Visual Impairment Project[9,b]	1992–1996	Australia	40–98	3268	White	0.6	0.1	1.0	0.3	Yes
Salisbury Eye Evaluation Study[10]	1993–1995	U.S.	65–84	1853	White	1.6	0.2	3.0	0.5	Yes
				666	Black	3.3	0.8	5.6	1.7	
National Eye Survey[11,a]	1996–1997	Malaysia	0–96	18027	Asian	2.4	0.3	N/A	N/A	Yes
Not defined[12,a]	1998	Hong Kong	60+	3434	Asian	N/A	0.5	N/A	N/A	Yes
Proyecto Vision Evaluation and Research[13]	1997–	U.S.	40+	4774	Hispanic	N/A	N/A	1.9	0.3	No
Andhra Pradesh Eye Disease Study[14]	1996–2000	India	whole	10293	Asian	1.05	N/A	N/A	0.4	No

NILS-LSA, National Institute for Longevity Sciences–Longitudinal Study of Aging; N/A: not applicable.
[a]Only pinhole correction, not using refraction.
[b]Institutionalized people were included.

compared to that of other studies is likely due to our subjects all being under the age of 80. It is also possible that the exclusion of institutionalized individuals caused underestimation of the visual impairment rate in our results, as this portion of the population tends to have visual impairment more frequently than the community-dwelling population.[5,7]

In addition to age, the risk factor for visual impairment that remained in the multivariate logistic regression model was the presence of myopia. One of the reasons for the association between myopia and visual impairment seems to be the frequent occurrence of cataract in myopic eyes. Several epidemiological surveys[25–27] have shown that myopia is an independent risk factor for cataract. Another explanation may be myopic macular degeneration. The Rotterdam Study reported that myopic macular degeneration was the predominant cause of visual impairment in subjects younger than 75 years of age.[7] In fact, our previous study demonstrated that the frequency of high myopia subjects, who are prone to myopic macular degeneration, is 0.5% in the NILS-LSA population.[28]

The inverse association between education level and household income with visual impairment is consistent with a study in an Appalachian community[4] and the Beaver Dam Eye Study.[29] Remarkably, the strong association between education level and visual impairment persisted even after being adjusted for age and myopia in the multiple logistic analysis. One would expect, them, that those with less education or a lower household income would have less knowledge of appropriate eye care. In fact, some previous studies[24,29,30] indicated that the risk of cataract decreased with higher education. We could not estimate the degree of cataract in the present study, but a similar association between education level and cataracts may be responsible for our results. Although our study showed an inverse relation between income level and visual acuity, no association was found between visual acuity and socioeconomic status in the Blue Mountains Eye Study.[8] Therefore, the association between visual impairment and socioeconomic status needs further investigation.

Contrary to our expectation, there was no significant association between a history of diabetes and visual impairment, even though diabetic retinopathy is the leading cause of blindness in the Japanese.[31] A probable reason is that, although diabetes is a relatively frequent disorder, active proliferative retinopathy (which causes visual impairment) seems to be rare in community-dwelling populations. The lack of association between visual impairment and cataract surgery in the multiple logistic analysis also seems to be due to the small number of our subjects having a history of cataract surgery.

In the present study, we did not use the Japanese criteria for the visually handicapped to compare our data with the data of other countries. It is advisable to identify visual impairment by assessing both visual acuity and visual field testing, as is done in the Japanese classification. In epidemiological surveys for community-dwelling populations, however, it is difficult to assess the visual field in detail with