た。本調査では四訂を用いた場合も五訂を用いた場合も，米はめしのコードを麺はゆでのコードを使用した。五訂収載のめしのコードの水分量が四訂収載のめしのコードの水分量より低下しているため，それに伴いめしのエネルギー，炭水化物量が増加していることが影響していると考えられる。ミネラル類では四訂を用いて算出した値と五訂による値の差がナトリウム（−8.2%），リン（5.7%），鉄（−16.0%），食塩相当量（−8.3%）で大きく，ビタミン類ではカロテン（30.9%），レチノール当量（18.6%），ビタミンB類（$B_1$ −6.5%，$B_2$ −5.2%），ナイアシン（10.3%）で大きかった。カロテンは四訂ではβ-カロテン当量（μg），五訂ではβ-カロテン（μg）と1/2α-カロテン（μg），1/2クリプトキサンチン（μg）の和に改訂された。五訂を用いて算出したレチノール当量が増加したのは五訂を用いて算出したβ-カロテン摂取量が四訂を用いて算出した値より増加したためと思われる。その他のビタミン，ミネラル類についてはそれぞれの食品における栄養素組成値の改訂による影響と思われる。対応のある *t*-検定においてタンパク質，レチノール以外のすべての栄養素等摂取量は四訂を用いて算出した場合と五訂を用いた場合に有意差がみられたことから，これらの栄養素では四訂あるいは五訂を用いて算出した栄養素等摂取量を比較する場合，成分表改訂の影響が統計学的に存在することを考慮する必要があることが明らかとなった。これらの結果は独自コードを除外して算出した場合も同様であったことから，独自コードの影響を受けて四訂または五訂を用いて算出した値が異なった可能性は極めて小さいと思われる。また1食品1成分値の対応が困難であった食品には実際の食事調査で使用していない食品が多かったが，これらを除外して算出した場合も結果は同様であった。Matsuda-Inoguchi *et al.*[8] は四訂でコード化し四訂を用いて算出した栄養素等摂取量と五訂でコード化し直し，五訂で算出した栄養素等摂取量とを比較しているが，鉄の摂取量が13%，食塩相当量値が3%四訂を用いた値より五訂を用いた値が減少したと報告している。また寺本ら[22] は病院給食食品群別加重平均栄養成分値を四訂および五訂を用いて算出し，実際の栄養素等給与量に対する食品成分表改訂の影響を検討しているが，エネルギー，三大栄養素では大差が認められず，五訂を用いると鉄は四訂の算出値より低値，ビタミンAは高値となることを報告している。五訂を用いて算出するとタンパク質，ナトリウム，カルシウム，鉄摂取量が減少する（君羅ら，日本栄養・食糧学会，2002年），鉄摂取量が減少する（多島ら，日本栄養改善学会，2002年），カロテン摂取量は増加し食塩相当量，ビタミン$B_1$，$B_2$，ビタミンCは低下する（高橋ら，日本栄養・食糧学会，2003年）などの学会報告もあることから，四訂あるいは五訂を用いて算出した栄養素等摂取量はデータベース変換による影響を受けることは確かではないかと思われる。

また四訂を用いて算出した栄養素等摂取量と五訂を用いて算出した栄養素等摂取量との相関係数は非常に高く，すべての栄養素摂取量で有意であった。エネルギー調整を行っても同様の結果であり，四訂，五訂日本食品成分表による栄養素等摂取量の関連はきわめて高いことがうかがわれた。しかし切片を0に調整した回帰分析の95%信頼区間をみると脂質，ナトリウム，カルシウム，鉄，食塩相当量，レチノール，ビタミンB類，ビタミンC値では95%信頼区間が上限下限とも1.000より小さく，五訂を用いた値が四訂を用いた値より系統的に低い値に計算される可能性がある一方，エネルギー，炭水化物，リン，カロテン，レチノール当量，ナイアシン摂取量などは下限上限とも1.000より大きく，五訂を用いて算出した値が四訂を用いた値より系統的に高い値に計算される可能性があることが考えられた。これらの栄養素等摂取量ではデータベースを変換すると，値に系統的な誤差が生じる可能性が大きいことから，四訂を用いて算出した過去の栄養素等摂取量と五訂を用いて算出した栄養素等摂取量を縦断的に比較する場合は，食品成分表改訂が栄養素等摂取量に影響を与える可能性を考慮する必要があると思われる。

本研究では四訂食品コードを五訂食品コードに置き換えた。五訂日本食品成分表には四訂日本食品成分表にはなかった野菜類の冷凍食品や，肉類の焼き，ゆでなどの調理形態別の食品番号が新たに収載されているが，本研究ではこれらの新食品番号への展開は不可能であった。食品の調理，加工，保存により栄養素含有量に変化[23]があることが報告されていることから，五訂食品番号を用いる場合は可能な限り調理形態別食品番号を使い分ける必要があると思われる。今後は四訂でコード化した食事データを新規に増えた調理形態別食品番号も含むすべての五訂食品番号で再度コード化し直し，その差を検討する必要があると思われる。また，四訂使用時に出回っていた食品の成分は現在の五訂に示されている値よりも四訂に示されている値により近い可能性が考えられる。一方，1982年に四訂食品成分表が公表されたことから1990年代後半の食品成分はむしろ五訂に近い可能性も考えられることから，四訂を用いて算出した過去のデータを五訂に変換する際には，調査が行われた年度を考慮する必要もあるだろう。さらに，分析技術の進歩に伴う定量法の精度の向上により，四訂と五訂で大きく成分が異なる成分もあるため考慮する必要もあると考えられる。なお，付表1に示した食品には四訂から五訂に変換する際に適当な食品が見当たらないものがいくつかあった。各成分表で共通性のない食品の変換表についても，今後の検討課題と考える。

本研究では四訂日本食品成分表を用いて算出した栄養素等摂取量と，五訂日本食品成分表を用いて算出した栄養素等摂取量とを比較し，食品成分表改訂が栄養素等摂取量に与える影響を検討した。四訂による栄養素等摂取

量と五訂による栄養素等摂取量との間には強い相関がみられたが，両者の間には有意な違いがあった。多くの栄養素等摂取量には成分表改訂による系統的な誤差が存在することから，四訂を用いて算出した過去の栄養素等摂取量と五訂を用いて算出した栄養素等摂取量を縦断的に比較する場合は，成分表改訂の影響を考慮する必要があることが示唆された。

本研究の一部は厚生労働科学研究費補助金（がん予防等健康科学総合研究事業）により実施した。

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付表 1　1食品1成分値の対応が困難だった食品と対応させた五訂食品番号

| 四訂 | | 五訂 | |
|---|---|---|---|
| 食品番号* | 食品名 | 食品番号 | 食品名 |
| 01001a | あわ・穀粒・玄穀 | 1002 | あわ・精白粒 |
| 01003 | えんばく・玄穀 | 1004 | えんばく・オートミール |
| 01005a | おおむぎ・穀粒・玄皮麦 | 1005 | おおむぎ・七分つき押し麦 |
| 01005b | おおむぎ・穀粒・玄裸麦 | 1005 | おおむぎ・七分つき押し麦 |
| 01007a | 麦こがし・関東風 | 1010 | 麦こがし |
| 01008a | きび・穀粒・玄穀 | 1011 | きび・精白粒 |

付表 1　つづき

| 四訂 | | 五訂 | |
|---|---|---|---|
| 食品番号* | 食品名 | 食品番号 | 食品名 |
| 01031d | 即席中華めん・加熱乾燥冷し中華めん | 1058 | 即席中華めん・非油揚げ |
| 01031e | 即席中華めん・同上湯戻し | 1051 | 干し中華めん・ゆで |
| 01057 | 米ぬか | 1116 | 米こうじ |
| 01058 | そば・玄穀 | 1122 | そば粉・全層粉 |
| 01070a | ひえ・穀粒・玄穀 | 1139 | ひえ・精白粒 |
| 01072 | ライむぎ・玄穀 | 1142 | ライむぎ・全粒粉 |
| 02006 | さつまいも・芋粉 | 2009 | さつまいも・蒸し切干 |
| 03004b | 砂糖・車糖・中白 | 3004 | 車糖・三温糖 |
| 03011b | 砂糖・糖みつ・精製糖廃糖みつ | 3014 | 氷糖みつ |
| 04065c | 洋菓子・ビスケット・クッキー | 15098 | ソフトビスケット |
| 04073a | 洋菓子・ヌガー・あんず | 15111 | バタースコッチ |
| 04073b | 洋菓子・ヌガー・落花生 | 15111 | バタースコッチ |
| 04077a | 洋菓子・チョコレート・スイート | 15116 | ミルクチョコレート |
| 05003 | 鶏脂 | 11235 | 若鶏肉・皮・もも・生 |
| 05005 | 羊脂 | 14015 | 牛脂 |
| 05007 | マーガリン | 14020 | ソフトタイプマーガリン |
| 05007b | マーガリン・ハードタイプ | 14020 | ソフトタイプマーガリン |
| 05007c | マーガリン・高リノール酸タイプ | 14020 | ソフトタイプマーガリン |
| 06019 | ひまわりの種・乾 | 5027 | ひまわり・フライ・味付け |
| 07018a | だいず・脱脂大豆・種皮付き | 4026 | だいず・全粒・中国産・乾 |
| 07018b | だいず・脱脂大豆・脱皮 | 4026 | だいず・全粒・中国産・乾 |
| 07027 | 凍り豆腐・アンモニア処理 | 4042 | 凍り豆腐 |
| 08003 | あさひだい・生 | 10003 | まあじ・生 |
| 08058a | かつお・缶詰・水煮 | 10089 | そうだがつお・加工品・なまり |
| 08058b | かつお・缶詰・味付け | 10096 | そうだがつお・缶詰・味付け・フレーク |
| 08080a | べにざけ・くん製，冷くん | 10151 | べにざけ・くん製 |
| 08088c | さば・缶詰・トマト煮 | 10166 | さば・缶詰・味付け |
| 08088d | さば・缶詰・油漬け | 10166 | さば・缶詰・味付け |
| 08091 | さめ・卵 | 10113 | キャビア・塩蔵品 |
| 08096 | 塩さんま | 10177 | さんま・缶詰・味付け |
| 08099b | さんま・缶詰・トマト漬け | 10177 | さんま・缶詰・味付け |
| 08110a | まだい・生 | 10193 | まだい・養殖・生 |
| 08125 | 塩にしん | 10221 | にしん・くん製 |
| 08137 | ひらめ・生 | 10234 | ひらめ・天然・生 |
| 08166 | リング・生 | 10272 | メルルーサ・生 |
| 08180a | かき・缶詰・水煮 | 10294 | かき・缶詰・くん製油漬缶詰 |
| 08190 | ばいがい・水煮缶詰 | 10304 | ばいがい・生 |
| 08194 | はまぐり・味付け缶詰 | 10309 | はまぐり・つくだ煮 |
| 08197b | ほたてがい・缶詰・味付け | 10315 | ほたてがい・貝柱・水煮缶詰 |
| 08200 | もがい・生 | 10279 | あかがい・生 |
| 08219a | くるまえび・生 | 10321 | くるまえび・養殖・生 |
| 08219a1 | くるまえび・天然・生 | 10321 | くるまえび・養殖・生 |
| 08223 | こうじ漬け | 10331 | 干しえび・つくだ煮 |
| 08225 | 水煮缶詰 | 10329 | ブラックタイガー・養殖，生 |
| 08235 | くらげ・塩くらげ | 10370 | くらげ・塩蔵・塩抜き |
| 08251 | 梅焼 | 10382 | だて巻き |
| 09004b | うさぎ・肉・野うさぎ | 11003 | うさぎ・肉・赤肉・生 |
| 09006c | うし・かた・脂身なし・乳用雌牛 | 11031 | 乳用肥育牛肉・かた・皮下脂肪なし・生 |
| 09007c | うし・かたロース・脂身つき・乳用雌牛 | 11034 | 乳用肥育牛肉・かたロース・脂身つき・生 |
| 09008c | うし・かたロース・脂身なし・乳用雌牛 | 11035 | 乳用肥育牛肉・かたロース・皮下脂肪なし・生 |
| 09009c | うし・リブロース・脂身つき・乳用雌牛 | 11037 | 乳用肥育牛肉・リブロース・脂身つき・生 |
| 09010c | うし・リブロース・脂身なし・乳用雌牛 | 11040 | 乳用肥育牛肉・リブロース・皮下脂肪なし・生 |

付表 1 つづき

| 四訂 | | 五訂 | |
|---|---|---|---|
| 食品番号* | 食品名 | 食品番号 | 食品名 |
| 09011c | うし・サーロイン・脂身つき・乳用雌牛 | 11043 | 乳用肥育牛肉・サーロイン・脂身つき・生 |
| 09012c | うし・サーロイン・脂身なし・乳用雌牛 | 11044 | 乳用肥育牛肉・サーロイン・皮下脂肪なし・生 |
| 09013c | うし・ばら・脂身つき・乳用雌牛 | 11046 | 乳用肥育牛肉・ばら・脂身つき・生 |
| 09014a | うし・ばら・脂身なし・和牛 | 11087 | 子牛肉・ばら・皮下脂肪なし・生 |
| 09014b | うし・ばら・脂身なし・乳用肥育雄牛 | 11087 | 子牛肉・ばら・皮下脂肪なし・生 |
| 09014c | うし・ばら・脂身なし・乳用雌牛 | 11087 | 子牛肉・ばら・皮下脂肪なし・生 |
| 09014d | うし・ばら・脂身なし・輸入牛 | 11087 | 子牛肉・ばら・皮下脂肪なし・生 |
| 09015c | うし・もも・脂身つき・乳用雌牛 | 11047 | 乳用肥育牛肉・もも・脂身つき・生 |
| 09016c | うし・もも・脂身なし・乳用雌牛 | 11048 | 乳用肥育牛肉・もも・皮下脂肪なし・生 |
| 09018c | うし・そともも・脂身なし・乳用雌牛 | 11054 | 乳用肥育牛肉・そともも・皮下脂肪なし・生 |
| 09019c | うし・ランプ・脂身つき・乳用雌牛 | 11056 | 乳用肥育牛肉・ランプ・脂身つき・生 |
| 09020c | うし・ランプ・脂身なし・乳用雌牛 | 11057 | 乳用肥育牛肉・ランプ・皮下脂肪なし・生 |
| 09021c | うし・ヒレ・乳用雌牛 | 11059 | 乳用肥育牛肉・ヒレ・赤肉・生 |
| 09023b | うし・牛脂身・かたロース | 11033 | 乳用肥育牛肉・かた・脂身・生 |
| 09023d | うし・牛脂身・サーロイン | 11042 | 乳用肥育牛肉・リブロース・脂身・生 |
| 09023e | うし・牛脂身・ばら | 11042 | 乳用肥育牛肉・リブロース・脂身・生 |
| 09023g | うし・牛脂身・そともも | 11052 | 乳用肥育牛肉・もも・脂身・生 |
| 09023h | うし・牛脂身・ランプ | 11056 | 乳用肥育牛肉・ランプ・脂身つき・生 |
| 09036a | かも・肉・こがも | 11208 | かも・肉・皮なし・生 |
| 09038b | くじら・赤肉・塩蔵 | 11110 | くじら・肉・赤肉・生 |
| 09038c | くじら・赤肉・味付け缶詰 | 11110 | くじら・肉・赤肉・生 |
| 09039 | くじら・尾肉 | 11110 | くじら・肉・赤肉・生 |
| 09040b | くじら・うねす・すのこ | 11111 | くじら・うねす・生 |
| 09040c | くじら・うねす・ベーコン | 11111 | くじら・うねす・生 |
| 09041 | くじら・尾羽 | 11111 | くじら・うねす・生 |
| 09053 | にわとり・鶏脂身 | 11235 | 若鶏肉・皮・もも・生 |
| 09057 | にわとり・腸 | 11233 | 若鶏肉・筋胃・生 |
| 09070a | ぶた・ばら・脂身なし・大型種 | 11129 | ぶた・大型種肉・ばら・脂身つき・生 |
| 09070b | ぶた・ばら・脂身なし・中型種 | 11153 | ぶた・中型種肉・ばら・脂身つき・生 |
| 09077d | ぶた・豚脂身・ばら | 11128 | ぶた・大型種肉・ロース・脂身・生 |
| 09090b | ほろほろちょう・肉・もも | 11240 | ほろほろちょう・肉・皮なし・生 |
| 09090c | ほろほろちょう・肉・ささ身 | 11240 | ほろほろちょう・肉・皮なし・生 |
| 09091a | めんよう・かた・マトン | 11199 | めんよう・マトン・ロース・脂身付き・生 |
| 09094 | めんよう・羊脂身 | 14015 | 牛脂 |
| 10001 | あひる卵・全卵・生 | 12004 | 鶏卵・全卵・生 |
| 10016 | ロングエッグ | 12018 | たまごやき・厚焼きたまご |
| 11003a | 牛乳および乳製品・加工乳・普通 | 13004 | 加工乳・濃厚 |
| 11015 | 牛乳および乳製品・アイスミックスパウダー | 13009 | 全粉乳 |
| 11017b | 牛乳および乳製品・脱脂粉乳・輸入 | 13010 | 脱脂粉乳 |
| 11021 | 牛乳および乳製品・加糖脱脂練乳 | 13013 | 加糖練乳 |
| 11025 | 牛乳および乳製品・チーズフード | 13041 | チーズスプレッド |
| 12054 | だいこん類・まびき菜 | 6130 | だいこん・葉・生 |
| 12059 | だいこん類・奈良漬 | 6137 | だいこん・漬物・ぬかみそ漬 |
| 12102a | はくらん・結球葉・生 | 6233 | はくさい・結球葉・生 |
| 12102b | はくらん・結球葉・ゆで | 6234 | はくさい・結球葉・ゆで |
| 12102c | はくらん・結球葉・塩漬け | 6235 | はくさい・漬物・塩漬け |
| 12116a | べにばないんげん・若ざや・生 | 6010 | さやいんげん・若ざや・生 |
| 12116b | べにばないんげん・若ざや・ゆで | 6011 | さやいんげん・若ざや・ゆで |
| 13019e | うんしゅうみかん・果実飲料・果粒入り果実飲料 | 7032 | うんしゅうみかん・果実飲料・果粒入りジュース |
| 13026b | かき・生果・熟しがき | 7049 | かき・甘がき・生 |
| 13030 | かりん・缶詰 | 7053 | かりん・生 |
| 13032b | きんかん・生果・果皮 | 7056 | きんかん・全果・生 |
| 13032c | きんかん・生果・果肉 | 7056 | きんかん・全果・生 |

付表 1　つづき

| 四訂 | | 五訂 | |
|---|---|---|---|
| 食品番号* | 食品名 | 食品番号 | 食品名 |
| 13035 | くねんぼ・生果 | 7084 | タンゴール・砂じょう・生 |
| 13056 | なつみかん・マーマレード | 7046 | マーマレード・高糖度 |
| 13086 | りゅうがん・冷凍果 | 7144 | ライチー・生 |
| 13089c | りんご・果実飲料・果肉飲料 | 7151 | りんご・果実飲料・50%果汁入り飲料 |
| 14005 | きくらげ・味付け缶詰 | 8007 | きくらげ・ゆで |
| 140031 | きくらげ・きくらげ・乾 | 8006 | きくらげ・乾 |
| 14013 | はつたけ・生 | 8025 | エリンギ・生 |
| 14015 | ひらたけ・水煮缶詰 | 8027 | ひらたけ・ゆで |
| 14016 | ふくろたけ・水煮缶詰 | 8033 | マッシュルーム・水煮缶詰 |
| 15024 | てんぐさ・生 | 9026 | てんぐさ・ところてん |
| 15033a | もずく・生・塩蔵 | 9037 | おきなわもずく・塩蔵・塩抜き |
| 15036a | わかめ・湯通し塩蔵わかめ・塩蔵 | 9045 | わかめ・湯通し塩蔵わかめ・塩抜き |
| 15037a | わかめ・くきわかめ・生 | 9046 | わかめ・くきわかめ・湯通し塩蔵・塩抜き |
| 16004c | アルコール飲料・しょうちゅう・20度 | 16015 | しょうちゅう・乙類 |
| 16005a | アルコール飲料・ウイスキー・特級 | 16016 | ウイスキー |
| 16005c | アルコール飲料・ウイスキー・2級 | 16016 | ウイスキー |
| 16006b | アルコール飲料・ブランデー・1級 | 16017 | ブランデー |
| 16006c | アルコール飲料・ブランデー・2級 | 16017 | ブランデー |
| 16007a | アルコール飲料・ウオッカ・50度 | 16018 | ウオッカ |
| 16008b | アルコール飲料・ジン・37度 | 16019 | ジン |
| 16014b | アルコール飲料・キュラソー・ホワイト | 16028 | キュラソー |
| 16022a | 茶・かまいり茶・茶 | 16036 | せん茶・茶 |
| 16023a | 茶・番茶・茶 | 16036 | せん茶・茶 |
| 16024a | 茶・ほうじ茶・茶 | 16036 | せん茶・茶 |
| 16025a | 茶・玄米茶・茶 | 16036 | せん茶・茶 |
| 16026a | 茶・ウーロン茶・茶 | 16036 | せん茶・茶 |
| 16030a | その他の飲料・コーヒー・いり豆 | 16048 | ココア・ピュアココア |
| 16034a | その他の飲料・麦茶・粒 | 16036 | せん茶・茶 |
| 16035 | その他の飲料・紛末清涼飲料 | 16054 | サイダー |
| 17010c | 調味料・マヨネーズ・スプレッド | 17043 | マヨネーズ・卵黄型 |
| 17019a | 香辛料・粉わさび・純 | 17080 | わさび・粉・からし粉入り |
| 17029 | 香辛料・ペッパーソース | 17038 | チリソース |
| 17033b | その他・酒かす・みりん | 17053 | 酒かす |
| 18002a | カレー・缶詰 | 18001 | カレー・ビーフ・レトルトパウチ |
| 18007a | シチュー・缶詰 | 18011 | シチュー・ビーフ・レトルトパウチ |
| 18012b | ミートソース・レトルトパウチ | 17033 | ミートソース |

* 四訂の食品番号は一部の例外を除き，食品群上2桁，食品名下3桁，（細分アルファベット1桁）表示とした。

付表 2　四訂から五訂に食品番号を置き換える際に，独自コードとして五訂に残した四訂食品

| 食品番号* | 食品名 | 食品番号* | 食品名 |
|---|---|---|---|
| 01031a | こむぎ・即席中華めん・油揚げ乾燥めん | 08177b | あわび・缶詰・味付け |
| 01031b | こむぎ・即席中華めん・加熱乾燥冷やし麺 | 08182 | さざえ・味付け缶詰 |
| 01041f | こめ・穀粒・強化米 | 08233 | かに・かに子漬 |
| 01043e | こめ・全がゆ・はいが精米 | 11009b | 牛乳および乳製品・ヨーグルト・含脂加糖 |
| 01044e | こめ・五分がゆ・はいが精米 | 12055c | だいこん類・葉・ぬかみそ漬け |
| 01045e | こめ・おもゆ・はいが精米 | 12109b | ひのな・根・茎葉・塩漬け |
| 03003 | 砂糖・粗糖 | 14008 | しいたけ・つくだ煮 |
| 04047 | 洋菓子・ゼリー | 15022 | こんぶ・昆布巻 |
| 04052 | 洋菓子・ミルクプリン | 15038 | わかめ・めかぶわかめ・素干し |
| 08007 | あじ・まあじ・味付け缶詰 | | |

* 四訂の食品番号は食品群上2桁，食品名下3桁，（細分アルファベット1桁）表示とした。

*J Jpn Soc Nutr Food Sci* **59** : 21-29 (2006)

***Research Data***

# Nutrient Intakes Estimated from Standard Tables of Food Composition in Japan: Comparison of the 5th Revised Edition with the 4th Revised Edition

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(Received November 15, 2004 ; Accepted July 27, 2005)

***Summary*** : We compared nutrient intakes estimated from the 4th revised edition of the Standard Tables of Food Composition in Japan (4th) with those estimated from the 5th revised edition (5th). The influence of revision of the Standard Tables of Food Composition revision on nutrient intake estimations was examined. Nutrient intakes were calculated from the 4th using data on food intake in a three-day dietary record in a community of 2,110 men and women aged 40-82 years. Nutrient intakes were then recalculated using the 5th food code converted from the 4th food code. The nutrient intakes estimated by the 4th and the 5th were then compared. Mean differences (5th−4th) and mean percentage difference [{(5th−4th)/4th} × 100] between nutrient intakes calculated from the 4th and the 5th ranged from −2.1 mg (−16%; iron) to 1,132 μg (31%; carotene), and these differences were significant for all nutrient intakes except protein and retinol. Coefficients of correlation between the nutrient intakes estimated from the 4th and the 5th ranged from 0.934 (carotene) to 0.996 (energy and protein), which were highly significant. However, regression analysis showed a significant systematic error in the nutrient intakes estimated from the 4th and the 5th code.

***Key words*** : Standard Tables of Food Composition in Japan: 5th Revised Edition, Standard Tables of Foods Composition in Japan: 4th Revised Edition, revision of food composition tables, nutrient estimation, systematic error

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# 超高齢者医療の重要性
## 公衆衛生，社会医学的視点から

下方 浩史

Question & Answer

*Q*：超高齢者の医療やケアでは何が重要か？

*A*：医療の面では，超高齢者への治療の指針を含むガイドラインの設定が重要だが，まだ十分ではない．ケアの面ではターミナルケアのあり方を十分考慮することや，現在の生活の質を考慮した生活習慣への介入が重要である．

*Keyword*：将来推計人口，超高齢者の定義，超高齢者医療，生活習慣，死因

### 増加する超高齢者人口

日本人は世界一の長寿である．厚生労働省の平成16年度簡易生命表からの平均寿命では，男性78.64歳，女性84.59歳である．男性ではアイスランドなどの追い上げを受けつつあるが，女性は他の追従を許さない世界のトップであり，男女合わせると世界一の長寿であることは疑いはない．

65歳まで生存する人は，男性が85.7％，女性が93.0％であり，また80歳まで生存する人は，男性で55.2％，女性で76.8％となっている．65歳までの生存率は，ほぼ頭打ちであるが，80歳までの生存率は，さらに増加傾向が続いている．

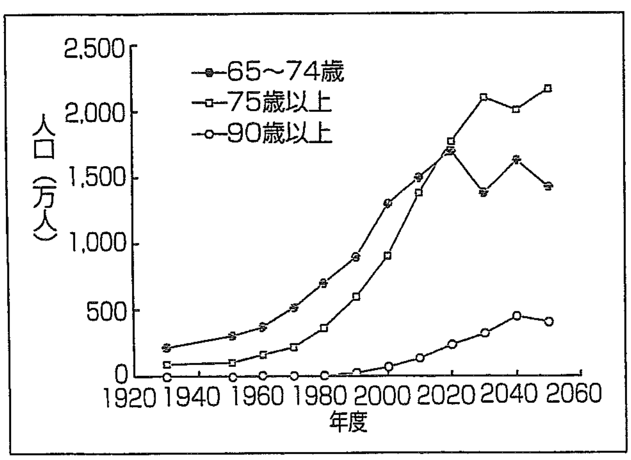


図1　前期高齢者・後期高齢者・超高齢者の将来推計人口
（国立社会保障・人口問題研究所「日本人の将来推計人口」平成14年1月推計による）

平均寿命の延長に伴って，高齢者人口は急速に増加している．平成17年度の「高齢社会白書」によると，平成16年10月1日時点での65歳以上の高齢者人口は2488万人で，総人口に占める割合は19.5％に達した．今後もこの増加は続くが，2015年には，日本の全人口の4人に1人が65歳以上の高齢者となる．高齢者のうちでも，とくに75歳以上の後期高齢者の人口が増えて，2020年以降には65～74歳までの前期高齢者の数よりも多くなると推定されている(図1)．

何歳から超高齢者とするか，統一された基準はない．わが国では癌治療などでは80歳以降，降圧治療などでは85歳以上を超高齢者としていることが多いが，平均寿命が延長し健康な高齢者が増える中で90歳以上を超高齢者とする立場も最近は多くなってきている．さらに100歳以上の超高齢者を百寿者という．

超高齢者の数は年々増加している．厚生労働省では毎年100歳以上の人たちを公表しているが，2005年度の百寿者は前年に比べ2,568人増えて25,606人に達し過去最多となった．このうち女性


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表1　85歳以上の高齢者の有訴率上位5症状および通院率上位5傷病
（厚生労働省平成16年度国民生活基礎調査）

| | | 第1位 | 第2位 | 第3位 | 第4位 | 第5位 |
|---|---|---|---|---|---|---|
| 有訴率の上位5症状 | 男性 | 聴こえにくい 21.2% | 腰痛 17.7% | もの忘れ 16.4% | 手足の動きが悪い 16.1% | 咳や痰が出る 13.8% |
| | 女性 | 聴こえにくい 19.7% | もの忘れ 19.0% | 腰痛 18.3% | 手足の動きが悪い 18.0% | 手足の関節が痛む 17.8% |
| 通院率の上位5傷病 | 男性 | 高血圧症 20.2% | 白内障 10.8% | 腰痛症 10.5% | 前立腺肥大症 9.5% | 狭心症・心筋梗塞 8.0% |
| | 女性 | 高血圧症 25.7% | 白内障 13.6% | 腰痛症 11.7% | 骨粗鬆症 8.9% | 関節症 8.2% |

は21,820人で，初めて2万人を超えた．女性の百寿者が1万人を超えたのは2000年で，たった5年で倍増した．1963年には百寿者は日本全体で153人しかいなかったことを考えると，驚くほどの増加である．

90歳以上の人口は1,016,000人に達し，初めて100万人の大台を超えた．1996年には47万人であった90歳以上の人口は8年で倍増し，2010年には134万人に，2040年には450万人に増加するものと推定されている．

## 超高齢者の健康状況・疾病

2004年度の国民生活基礎調査では，要介護者のうちの14.9％が90歳以上の超高齢者である．気になる自覚症状がなく，また日常生活活動に支障もなく，通院もしていない，まったくの健康状態にある人は85歳以上の高齢者の約10％にすぎない．85歳以上の61.8％が病気のために医療機関に通院しており，52.9％が心身に何らかの症状がある．85歳以上の高齢者の罹患疾病は男女ともに第1位は高血圧症，第2位は白内障，第3位は腰痛症で，男性では第4位が前立腺肥大症，第5位が狭心症・心筋梗塞，女性では第4位が骨粗鬆症，第6位が関節症となっている．高血圧症は男性で20.2％，女性で25.7％の人たちが受診している．

自覚症状は男女ともに1位は「聴こえにくい」であり，約20％の高齢者が訴えを持っている．「もの忘れ」「腰痛」「手足の動きが悪い」などの症状も多い(表1)．

## 超高齢者の死因

厚生労働省の人口動態調査による平成16年度の年齢階級別死因は，60～84歳までで，悪性新生物，心疾患，脳血管疾患の順であり，40～64歳までは脳血管障害の代わりに自殺が上位にあるのが特徴である．死因としては中年者でも高齢者でも基本的には大きな違いはない．しかし90歳以上では悪性新生物による死亡の割合が低下し，心疾患，脳血管疾患による死亡の割合が増加する．肺炎による死亡が男性では第1位，女性では第3位の死因となり，男女ともに肺炎による死亡が超高齢者では増加している．また死因としての「老衰」が男女ともに第5位に登場しているのも超高齢者の特徴である(表2)．

## 超高齢者医療の重要性

超高齢者の数は，これまではきわめて少数であり，臨床上の問題になかなかならなかった．しかし超高齢者人口は今後，加速度的に増加していく．一般高齢者よりもさらに多くの疾患や症状を

表2 中高年者の性・年齢階級別にみた死因順位
(厚生労働省平成16年度人口動態調査)

男性

| 年齢(歳) | 第1位 | 第2位 | 第3位 | 第4位 | 第5位 |
|---|---|---|---|---|---|
| 40～44 | 自殺 | 悪性新生物 | 心疾患 | 不慮の事故 | 脳血管疾患 |
| 45～49 | 悪性新生物 | 自殺 | 心疾患 | 脳血管疾患 | 不慮の事故 |
| 50～54 | 悪性新生物 | 心疾患 | 自殺 | 脳血管疾患 | 不慮の事故 |
| 55～59 | 悪性新生物 | 心疾患 | 自殺 | 脳血管疾患 | 不慮の事故 |
| 60～64 | 悪性新生物 | 心疾患 | 脳血管疾患 | 自殺 | 不慮の事故 |
| 65～69 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 70～74 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 75～79 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 80～84 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 85～89 | 悪性新生物 | 肺炎 | 心疾患 | 脳血管疾患 | 慢性閉塞性 |
| 90以上 | 肺炎 | 心疾患 | 悪性新生物 | 脳血管疾患 | 老衰 |

女性

| 年齢(歳) | 第1位 | 第2位 | 第3位 | 第4位 | 第5位 |
|---|---|---|---|---|---|
| 40～44 | 悪性新生物 | 自殺 | 心疾患 | 脳血管疾患 | 不慮の事故 |
| 45～49 | 悪性新生物 | 自殺 | 脳血管疾患 | 心疾患 | 不慮の事故 |
| 50～54 | 悪性新生物 | 脳血管疾患 | 心疾患 | 自殺 | 不慮の事故 |
| 55～59 | 悪性新生物 | 脳血管疾患 | 心疾患 | 自殺 | 不慮の事故 |
| 60～64 | 悪性新生物 | 心疾患 | 脳血管疾患 | 自殺 | 不慮の事故 |
| 65～69 | 悪性新生物 | 心疾患 | 脳血管疾患 | 不慮の事故 | 肺炎 |
| 70～74 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 75～79 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 80～84 | 悪性新生物 | 心疾患 | 脳血管疾患 | 肺炎 | 不慮の事故 |
| 85～89 | 心疾患 | 悪性新生物 | 脳血管疾患 | 肺炎 | 老衰 |
| 90以上 | 心疾患 | 脳血管疾患 | 肺炎 | 悪性新生物 | 老衰 |

持ち，寝たきりや要介護の頻度も高い．また，感染症に対する抵抗力が低下しており，肺炎などの重篤な感染症にかかりやすい．脱水や電解質異常などに対しても細心の注意が必要だ．

世界保健機関(WHO)と国際高血圧学会(ISH)による降圧治療のガイドラインでは，80歳代後半の超高齢者については，高血圧が循環系に直接悪影響を及ぼす場合を除いては，生活改善にとどめるべきとしている．

しかし，このような超高齢者への治療の指針を含むガイドラインの設定は，まだまだ少ない．超高齢者の健康対策，疾病予防，的確な治療の方法を確立させることが急務であろう．平均寿命が延びても，寝たきりの超高齢者が増加しては，介護や看護の負担が大きくなるばかりである．

一方で，超高齢者のターミナルケアのあり方にも配慮が必要だ．超高齢者の死因に「老衰」があるように，超高齢では天寿という考え方がある．しかし，医学が進歩した現在，人の命がどこまでが天寿なのかがわからなくなってきている．超高齢だからといって治療するのはまったく無駄だというのは間違いだろう．

医師にはすべての人にできる限りの治療をしていく義務がある．寝たきりになり，食事が取れなくなって経管栄養をするようでは生きている価値がないという考えは間違っている．家族も医師も，患者が生きる努力をしているのを止める権利はない．超高齢だからといって，差別することな

く治療を行っていくことが大切だ.

## 生活習慣の改善

75歳未満の前期高齢者は元気である．多くの人が職についており，また積極的に社会参加をしている．喫煙や飲酒のコントロール，肥満防止，栄養改善，運動習慣などの生活習慣の改善は，寝たきりを防止して健康寿命を延ばしていくためには不可欠である．一方，75歳以上の後期高齢者，さらには80歳以上の超高齢者では加齢による身体機能の変化に対応し，10年先，20年先のことよりも現在の生活の質を考慮した生活習慣への介入が必要だ.

超高齢者では，健康の維持のためにはとくに食欲の低下による栄養不良，体重減少を予防していくことが必要であり，食事の制限や減塩などはどうしても必要な場合に限るべきであろう．喫煙は肺炎や気管支炎のリスクであり避けるべきである．高齢者では肝臓でのアルコール代謝機能が低下している場合が多く，過度の飲酒も好ましくない.

高齢者の心身の健康の維持のために運動習慣への積極的な介入が必要である．寝たきりにならない，介護予防の実施がとくに必要である．筋力トレーニング教室，転倒予防教室などへの超高齢者の参加を積極的に進めていくべきであろう.

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*Circ J* 2006; **70:** 110–114

# Cutoff and Target Values for Intra-Abdominal Fat Area for Prevention of Metabolic Disorders in Pre- and Post-Menopausal Obese Women Before and After Weight Reduction

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**Background** The Japan Society for the Study of Obesity originally proposed a cutoff value of >100 cm² for the intra-abdominal fat area (IFA) as a definition for "visceral fat obesity" in Japanese adults. There are no studies on the cutoff or target values after weight reduction in pre- and post-menopausal women.
**Methods and Results** In the present study 149 pre-menopausal obese women (PreM, 43.3 years, 27.3 kg/m²) and 58 post-menopausal women (PostM, 53.9 years, 27.7 kg/m²) participated in a 14-week weight reduction program. The IFA was measured by computed tomography. The program induced significant reductions in body weight (8.6 kg in PreM and 7.8 kg in PostM). The IFA decreased significantly from 80.4±41.3 to 50.7±23.8 (PreM) and from 115.4±38.0 to 75.7±30.5 (PostM).
**Conclusions** The receiver-operating characteristic curve analyses revealed that the appropriate cutoff values were 80 cm² (PreM) and 110 cm² (PostM) before the program, and after the program the appropriate target values were determined as 60 and 70 cm², respectively. (*Circ J* 2006; **70:** 110–114)

**Key Words:** Diet; Exercise; Fat body; Menopause; Metabolic syndrome

The "visceral fat obesity" refers to the condition of excess intra-abdominal fat (IF), which places people having this type of excess fat at high risk for obesity-related metabolic disorders, such as hyperglycemia and dyslipidemia. The Japan Society for the Study of Obesity (JASSO)[1] originally defined visceral fat obesity in Japanese as having an IF area (IFA) >100 cm² and indicated that such people tend to have 1 or more metabolic disorders[1] Nakamura et al reported that approximately 62% of patients with coronary artery disease have an IFA =100 cm² or more,[2] and Banno et al found that sleep-disordered breathing was closely associated with obesity[3]

JASSO used a cross-sectional study design to validate the cutoff value for IFA of 100 cm² for the diagnosis of visceral fat obesity,[1] but intervention studies for assessing an appropriate target value that can be used for people who reduce their IF significantly have been lacking, and it is unclear whether, or at what point, decreasing IF improves metabolic disorders.

*(Received August 26, 2005; revised manuscript received October 19, 2005; accepted November 4, 2005)*
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There are several studies of the effects of menopause on the relationship of IF with metabolic diseases. Excess IF deposition is more prevalent in post-menopausal women than in pre-menopausal women[4] although it occurs more frequently in males of all ages[5] Hunter et al[6] and Gower et al[7] showed that the IFA and the risk of coronary heart disease (CHD) were positively correlated and that each average in post-menopausal women was higher than that in pre-menopausal women. The results of the study by Rebuffe-Scrive et al[8] suggest that one of the reasons for this phenomenon is the more pronounced activation of lipoprotein lipase in the omental adipose tissue of post-menopausal women than in that of pre-menopausal women. The cutoff value for the IFA derived by JASSO[1] was defined using a combination of pre- and post-menopausal women; the standards were, therefore, not established while considering the presence of menopause.

Based on these results, the current study assesses JASSO's visceral fat obesity IFA cutoff value of 100 cm² in pre- and post-menopausal women and also assesses the IFA target value after a weight reduction program. We tested 2 related hypotheses: (1) the cutoff value would be valid when applied to a group consisting of only pre- or post-menopausal women and (2) it would remain valid in each group after reducing the IFA.

## Methods

### *Participants*

Advertisements were placed in local newspapers and on bulletin boards in Toride City in Ibaraki Prefecture and Abiko City in Chiba Prefecture in Japan to locate potential participants with a desire to lose weight. Those who responded to the advertisements were interviewed by telephone. The participants supplied information on demographics, menstrual status, and medical history. They were excluded from the study if their weight had been unstable for the past 6 months, if they had attended any weight reduction programs in the past year, or if they were breast feeding or pregnant. A study physician confirmed if participants were possibly pregnant. Further, the study staff and radiologic technologist explained to all participants that computed tomography (CT) can have deleterious effects. After applying the exclusion criteria to potential participants, the selected participants (n=220) received the details of the study's purpose and protocol. Oral informed consent, following the Helsinki Declaration principles and approved by the Higashi Toride Hospital Review Board, was obtained from each person. We defined "menopause" as the status of no menses for 1 year prior to the study. "Pre-menopause" was used define individuals who were not experiencing menopause. Therefore, the pre-menopausal group consisted of women who declared having menses in the year prior to the study (PreM). The post-menopausal group included those women who had not had menses for more than 1 year prior to the beginning of the study (PostM).

*IFA*

We measured the IFA and subcutaneous fat area (SFA) at the level of the umbilicus using cross-sectional CT (SCT-6800TX; Shimadzu, Japan). Scans were performed with the participants in the supine position. Details of the scanning have been reported by Tokunaga et al[9] and Yoshizumi et al.[10] Measurements taken before and after the program were conducted at the same time of day by the same technician to minimize technical error. The IFA and SFA were calculated using a computer-software program (FatScan; N2system, Japan).[10] The intra-class correlation for repeated IFA determinations in the laboratory (Institute of Health and Sport Sciences, University of Tsukuba) is 0.99 (n=30).

*Obesity-Related Metabolic Disorders*

The obesity-related metabolic disorders were defined as follows: accumulation of IF (waist circumference ≥90cm in female) plus 2 or more co-morbidities consisting of (i) triacylglycerol (TG) ≥150mg/dl and/or high-density lipoprotein cholesterol (HDLC) <40mg/dl, (ii) systolic blood pressure (SBP) ≥130mmHg or diastolic blood pressure (DBP) ≥85mmHg, or (iii) fasting plasma glucose ≥110mg/dl.[11,12] These biochemical assays were performed on approximately 10ml of blood drawn from each participant after an overnight fast. The blood assays were analyzed by technicians at the Koto Biken Research Institute in Tsukuba, Japan. Total body composition was assessed by bioelectrical impedance methods.[13] We used the Tanaka formula[13] to estimate the total body density (Db) and the Brozek formula[14] to determine the percentage of body fat. The Tanaka formula accurately predicts the total Db in obese Japanese women (R=0.903, SEE=0.0061 g/cm$^3$, with the hydrodensitometrically determined Db). SBP and DBP were taken from the right arm using a mercury manometer after at least a 20-min rest while seated. Cuff sizes were selected based on upper arm girth and length.

*Weight Reduction Program*

A 14-week weight reduction program was monitored by a physician, dietician, exercise instructors, and graduate school students majoring in exercise intervention. After the baseline assessment, participants received instruction on the diet program, which comprised weekly 90-min diet consultations, at which a diet-recording notebook and several handouts were given to participants to help them adhere to the principles of the daily diet. They were asked to take a well-balanced supplemental food product (MicroDiet; Sunny Health Co, Ltd, Japan) daily as 1 of their meals, preferably as lunch or dinner. The MicroDiet, which includes various amino acids, vitamins, and minerals, was developed for very low-energy diets. To prevent boredom, the MicroDiet was served in 7 flavors: coffee, milk tea, cocoa, yogurt, banana, strawberry, and apple. Participants received packages consisting of 7 meals (each flavor) once a week. The nutritional values for each flavor were slightly different (ie, there was a range for protein (20.6–21.5g), carbohydrate (15.0–18.1g), fat (1.6–3.0g), and energy (169–173kcal) for each meal). The diet records were obtained from 86 participants (60 in the PreM group, 26 in the PostM group), who were randomly selected. One week before the study, the participants were asked to record everything they had eaten for the 3 days prior to the study. Furthermore, they were asked to record their diets for 3 days during week 7, the midpoint of the intervention.

The exercise program included 3 weekly 45-min sessions. During the first and second weeks of the 14-week program, exercise sessions consisted mainly of walking and stretching, with the gradual addition of a bench-stepping exercise[15] as the main element. Thereafter, the exercise session consisted of a 10-min warm-up, 25-min bench stepping, and a 10-min cool-down. The bench stepping targeted an exercise intensity in which the participant's heart rate reached a level 10–15% higher than the level corresponding to her lactate threshold (LT). The LT was defined as the point at which blood lactate concentration maintained a non-linear increase above the level at rest.[16] To determine LT, a series of venous blood samples (1ml each) was drawn from the antecubital vein every minute during a maximal cycling exercise test, which was done with an accompanying electrocardiogram as a baseline assessment. All blood samples were analyzed by the electrochemical enzymatic method using a lactate analyzer (model 23L, YSI Inc, OH, USA). For establishing LT, the log (oxygen uptake)–log (lactate) transformation method was used.[16]

Exercise was consistently performed for 45 min throughout the 14 weeks, but the intensity was progressively increased. In the first 2 weeks, the bench-stepping instructor targeted the intensity as described. After the 3rd week, the instructor progressively increased the intensity by increasing the cadence of the step and adding more dynamic movements. Ratings of the perceived exertion (RPE)[17] by all participants were also monitored during the bench stepping. Based on their RPE, the instructor moderated the intensity as "somewhat hard" to "hard," which corresponded to LT or a little above LT.[18]

*Statistical Analysis*

Differences in variables between the beginning and end of the program were tested in each group by using Student's paired t-tests. Data were analyzed with the SPSS 11.01J statistical software package (SPSS, Chicago, IL, USA), and P-values less than 0.05 were considered statistically significant.

To assess the cutoff value (before weight reduction) and

**Table 1 Baseline Characteristics of Participants**

| | PreM + PostM (n=207) | PreM (n=149) | PostM (n=58) |
|---|---|---|---|
| Age (years) | 46.2±8.1 | 43.3±6.7 (24–57) | 53.9±6.0 (45–62) |
| Height (cm) | 157.0±5.2 | 157.9±5.1 (146.1–171.8) | 154.6±4.9 (145.6–165.4) |
| Weight (kg) | 67.6±8.2 | 68.1±7.6 (53.6–87.6) | 66.3±9.7 (50.0–111.3) |
| Body mass index (kg/m²) | 27.4±3.0 | 27.3±2.9 (21.8–37.3) | 27.7±3.3 (20.9–40.7) |
| Percent body fat (%) | 34.6±4.9 | 34.1±4.2 (24.9–46.7) | 35.9±6.2 (24.1–51.9) |
| Intra-abdominal fat area (cm²) | 90.2±43.3 | 80.4±41.3 (12.2–222.9) | 115.4±38.0 (32.3–191.2) |
| Subcutaneous fat area (cm²) | 252.2±82.1 | 250.9±75.4 (103.5–548.0) | 255.5±97.9 (90.5–684.0) |
| Abdominal circumstance (cm) | 95.7±8.6 | 95.1±8.4 (73.8–118.0) | 97±8.9 (80.5–131.5) |

*Values are means ± standard deviations (minimum–maximum).*
*PreM, pre-menopausal obese group; PostM, post-menopausal obese group.*

**Table 2 Effects of a 14-Week Weight Reduction Program on Anthropometric Variables, Abdominal Fat Area, Metabolic Variables, and Blood Pressures**

| | PreM + PostM (n=207) | | PreM (n=149) | | PostM (n=58) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| Weight (kg) | 67.6±8.2 | 59.3±7.4* (–12%) | 68.1±7.6 | 59.6±6.9* (–12%) | 66.3±9.7 | 58.5±8.5* (–12%) |
| Body mass index (kg/m²) | 27.4±3.0 | 24.0±2.7* (–12%) | 27.3±2.9 | 23.9±2.6* (–12%) | 27.7±3.3 | 24.4±2.9* (–12%) |
| Percent body fat (%) | 34.6±4.9 | 29.4±4.6* (–15%) | 34.1±4.2 | 28.8±4.0* (–15%) | 35.9±6.2 | 31.1±5.5* (–13%) |
| Intra-abdominal fat area (cm²) | 90.2±43.3 | 57.7±28.1* (–32%) | 80.4±41.3 | 50.7±23.8* (–31%) | 115.4±38.0 | 75.7±30.5* (–34%) |
| Subcutaneous fat area (cm²) | 252.2±82.1 | 181.6±76.9* (–29%) | 250.9±75.4 | 176.2±73.2* (–31%) | 255.5±97.9 | 195.5±84.6* (–24%) |
| Abdominal circumference (cm) | 95.7±8.6 | 85.2±8.6* (–6%) | 95.1±8.4 | 84.9±8.0* (–5%) | 97.3±8.7 | 86.2±10.0* (–7%) |
| Fasting plasma glucose (mmol/L) | 5.41±1.13 | 4.94±0.68* (–7%) | 5.25±0.86 | 4.88±0.68* (–6%) | 5.84±1.57 | 5.10±0.67* (–10%) |
| Total cholesterol (mmol/L) | 5.71±0.95 | 5.17±0.89* (–9%) | 5.59±0.95 | 5.02±0.83* (–9%) | 6.00±0.89 | 5.57±0.92* (–7%) |
| Triacylglycerol (mmol/L) | 1.18±0.59 | 0.80±0.41* (–23%) | 1.13±0.59 | 0.76±0.38* (–24%) | 1.30±0.58 | 0.91±0.48* (–21%) |
| HDLC (mmol/L) | 1.70±0.38 | 1.65±0.33* (–1%) | 1.72±0.36 | 1.65±0.32* (–2%) | 1.66±0.44 | 1.65±0.35 (+2%) |
| SBP (mmHg) | 132.4±18.8 | 120.6±16.5* (–8%) | 129.9±17.9 | 118.6±15.5* (–8%) | 138.7±19.7 | 125.8±17.7* (–9%) |
| DBP (mmHg) | 82.1±11.7 | 74.4±11.0* (–9%) | 81.0±11.5 | 74.2±10.5* (–8%) | 84.9±11.9 | 74.8±12.4* (–12%) |

*Values are means ± standard deviations (relative change, %).*
*PreM, pre-menopausal obese group; PostM, post-menopausal obese group; HDLC, high-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.*
**Significant intra-group difference (P<0.05).*

**Table 3 Number and Percentage of Participants That Exceeded Each Criterion of the Metabolic Disorders Before and After Weight Reduction Program**

| | PreM (n=149) | | PostM (n=58) | |
|---|---|---|---|---|
| | Before | After | Before | After |
| High abdominal circumference | 112 (75%) | 37 (25%) | 50 (86%) | 18 (31%) |
| High triacylglycerol and/or low HDLC | 27 (18%) | 6 (4%) | 11 (19%) | 6 (10%) |
| High triacylglycerol | 26 (17%) | 5 (3%) | 9 (16%) | 5 (9%) |
| Low HDLC | 3 (2%) | 3 (2%) | 4 (7%) | 2 (3%) |
| High systolic and/or diastolic blood pressure | 80 (54%) | 36 (24%) | 41 (71%) | 23 (40%) |
| High systolic blood pressure | 74 (50%) | 33 (22%) | 39 (67%) | 23 (40%) |
| High diastolic blood pressure | 52 (35%) | 22 (15%) | 28 (48%) | 8 (14%) |
| High fasting plasma glucose | 11 (7%) | 6 (4%) | 14 (24%) | 6 (10%) |

*Abbreviations see in Table 2.*

the target value (after weight reduction) for IFA, receiver-operating characteristic (ROC) curve analysis was applied to the data derived from the IFA and the number of metabolic disorders. By provisionally varying the cutoff/target values of IFA, we calculated the sensitivities and specificities for each value. Sensitivity was defined as the proportion of participants having a given disorder who also had an IFA equal to or greater than the provisional value to all participants having a given disorder. Specificity was defined as the proportion of participants having no disorders who had an IFA that fell below the provisional value to all participants having no disorders. The sensitivities and specificities were calculated for every 10 cm² of IFA from 30 to 140 cm². At each 10 cm² provisional value, the sensitivity was multiplied by the specificity, and the point having the maximum product of sensitivity × specificity was considered to be the most valid cutoff/target value.

## Results

Of the 220 women originally enrolled in this study, 13 dropped out because they moved out of the area, needed to care for a family member, or felt fatigued. Consequently, 207 women completed the study (Table 1), and attendance averaged 92% (range 83–100%).

There were significant decreases in the anthropometric variables, IFA, SFA, metabolic variables, and blood pressures in each group (Table 2). Total body composition analysis revealed that the reduction in body weight was mostly from loss of body fat. The reduction in fat-free mass

**Table 4 Sensitivities and Specificities From Each Provisional Cutoff/Target Value of Intra-Abdominal Fat Area (IFA)**

| *Cutoff/target value (IFA, cm²)* | *PreM* | | | | *PostM* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Before* | | *After* | | *Before* | | *After* | |
| | *Sensitivity* | *Specificity* | *Sensitivity* | *Specificity* | *Sensitivity* | *Specificity* | *Sensitivity* | *Specificity* |
| 30 | 0.96 | 0.04 | 0.93 | 0.22 | 1.00 | 0.00 | 1.00 | 0.06 |
| 40 | 0.91 | 0.23 | 0.87 | 0.42 | 1.00 | 0.06 | 1.00 | 0.11 |
| 50 | 0.89 | 0.37 | 0.73 | 0.57 | 0.98 | 0.12 | 1.00 | 0.3 |
| 60 | 0.80 | 0.47 | 0.67 | 0.71 | 0.95 | 0.18 | 0.91 | 0.40 |
| 70 | 0.72 | 0.55 | 0.33 | 0.82 | 0.93 | 0.29 | 0.91 | 0.63 |
| 80 | 0.63 | 0.74 | 0.27 | 0.89 | 0.90 | 0.41 | 0.82 | 0.66 |
| 90 | 0.53 | 0.81 | 0.07 | 0.96 | 0.88 | 0.59 | 0.64 | 0.72 |
| 100 | 0.45 | 0.89 | 0.07 | 0.98 | 0.85 | 0.59 | 0.64 | 0.79 |
| 110 | 0.40 | 0.95 | 0.07 | 0.99 | 0.73 | 0.71 | 0.45 | 0.96 |
| 120 | 0.27 | 0.96 | 0.07 | 0.99 | 0.56 | 0.82 | 0.36 | 0.98 |
| 130 | 0.21 | 0.97 | 0.07 | 1.00 | 0.41 | 0.94 | 0.18 | 1.00 |
| 140 | 0.16 | 0.97 | 0.00 | 1.00 | 0.29 | 0.94 | 0.09 | 1.00 |

*Abbreviations see in Table 1.*
*Underlined values indicate the most valid cutoff/target values.*

was significant, but the absolute change was less than the change in fat mass.

The daily average energy intake in the PreM group was 2,100±354kcal at 1 week before the study and it decreased significantly to 1,163±242kcal. The PostM group significantly reduced their energy intake from 1,870±394kcal to 1,029±152kcal. The daily protein intake in the PreM group was 78.1±15.1g, and it decreased significantly to 70.3±14.2g. In the PostM group, it decreased significantly from 86.1±33.5g to 65.1±9.0g. The daily fat intake decreased significantly from 66.3±14.9g to 33.1±9.9g in the PreM group and from 56.6±20.4g to 27.4±6.2g in the PostM group. The daily carbohydrate intake also decreased significantly from 285.5±61.2g to 147.5±31.3g in the PreM group and from 272.3±94.1g to 136.1±23.8g in the PostM group.

The percentage of participants that exceeded each criterion of the metabolic disorders is shown in Table 3. More than 50% of the participants had a high abdominal circumference before the program (PreM, 75%; PostM, 86%). The most frequent disorder in both groups was hypertension, with hyper-SBP (PreM, 50%; PostM, 67%) and hyper DBP (PreM, 35%; PostM, 48%). After the program, the percentages of all disorders, except for hypo-HDLC in the PreM group, decreased.

The characteristics of the 12 provisional cutoff/target values for IFA from 30 cm² to 140 cm² are presented in Table 4. Sensitivities before the program ranged from 0.16 to 0.96 in the PreM group and from 0.29 to 1.00 in the PostM group. Specificities ranged from 0.04 to 0.97 for the PreM group and from 0.00 to 0.94 for the PostM group. The products obtained by multiplying the sensitivity by the specificity at each provisional value ranged from 0.04 to 0.47 in the PreM group and from 0.00 to 0.52 in the PostM group. The largest products of sensitivity and specificity were found at 80 cm² (0.47) for the PreM group and 110 cm² (0.52) for the PostM group. Therefore, the cutoff values with the best equilibrium between sensitivity and specificity approached 80 cm² in the PreM group and 110 cm² in the PostM group before weight reduction. Using the same method of analysis, the most valid target values after the weight reduction program were determined to be 60 cm² for the PreM group and 70 cm² for the PostM group.

## Discussion

In only a few studies, attempts have been made to determine the cutoff or target value for obesity-related metabolic disorders.[1,19,20] In the present study the cutoff values of IFA were 80 cm² for pre-menopausal women and 110 cm² for post-menopausal women before weight reduction, which are similar to the 100 cm² value considered appropriate by JASSO[1] in a study that did not differentiate between pre- and post-menopausal women. Williams et al, in a combined study of both pre- (n=133) and post-menopausal women (n=87), concluded that 110 cm² was the cutoff value for IFA above which the risk of metabolic disorders increases.[20] Despres and Lamarche indicated that 130 cm² of IFA was the point at which the metabolic risks increase significantly, derived from a sample of 115 males and 72 females.[19] Considering those findings, the cutoff values in the current study seem to be reasonable.

A difference of 30 cm² in the cutoff values was noted between the PreM women (80 cm²) and the PostM women (110 cm²) before weight reduction. Williams et al reported that menopause has little effect on the risks of metabolic disorders, such as HDLC, TG, SBP, DBP, and TC:HDLC ratio,[20] although in a review by Knopp,[21] post-menopausal women were found to have elevated risks because of decreased estrogen contributing to increased low-density lipoprotein cholesterol (LDLC) and decreased HDLC concentrations. Hunter et al[6] have also reported that post-menopausal women showed a greater IFA than pre-menopausal women and that menopausal status was significantly related to an increased risk for CHD risk factors (ie, LDLC, TC:HDLC ratio). Therefore, in the current study, the cutoff values were expected to differ according to the menopausal status of the participants. Because estrogen decreases the risk of CHD during the pre-menopausal period, perhaps counterbalancing some of the CHD risks brought on by excess IF,[21] further assumptions were made that the cutoff value for PreM women would be the same or even greater than that of PostM women. The ROC analyses revealed a difference of 30 cm² between the cutoff values in each group, but the value of the PreM group was lower than that of the PostM group. The study from the Women's Health Initiative also showed that estrogen would not confer benefits for preventing CHD among women with estrogen plus progestin therapy relative to women given a placebo.[22]

There seem to be other factors in addition to estrogen affecting the risk of metabolic disease; for example, aging, which correlates to an increase in IFA[2,6,23] and adiponectin[24] may be a factor.

In previous studies, a cross-sectional design was used to determine an IFA cutoff value[1,19,20] but because it is also important to determine a target IFA value for reducing the risk of metabolic disease, an intervention design was used in the current study. The IFA relates to the risk of obesity-related metabolic disorders; therefore, we assumed that the target values after weight reduction would remain the same as before the program, but they were lower. Although the reasons for this are unclear, we speculate that once a person is suffering from a metabolic disorder, a significant reduction in IFA may not be enough in itself to ameliorate the situation.

*Study Limitations*

The reasons for the relatively low sensitivities and specificities derived from IFA and metabolic disorders are unclear. Some unmeasured factors, such as diet and the genetic effect of metabolic disorders, may play a part. Furthermore, homeostasis was not maintained during and just after the weight loss. Another limitation is that the number of participants was small and that the mean body mass index or IFA was not very high, although most participants were obese. Future studies should include a larger number of extremely obese participants to verify the target values for risk of IFA after weight reduction. A significant decrease in HDLC in the PreM group was found after weight reduction, which may have been caused by the diet. Hagan et al[25] reported that HDLC decreased as middle-aged women lost body weight during a 12-week diet program. The significant decrease in TC could be attributed to the fact that TC includes HDLC.

In conclusion, this study presents the cutoff values for IFA in both pre- and post-menopausal obese women, as well as the target values after weight reduction, which are useful for the diagnosis of obesity-related metabolic disorders. Before weight reduction, the cutoff values with the best equilibrium were 80 $cm^2$ for pre-menopausal women and 110 $cm^2$ for post-menopausal women. After weight reduction, the target values shifted to 60 $cm^2$ and 70 $cm^2$, respectively. Using these values, persons diagnosed with visceral fat obesity can clearly see the benefits of engaging in a diet and exercise program. Furthermore, awareness of a target value makes adherence to the program more likely.

## Acknowledgments

*This work was supported in part by Grants-in-Aid from the Japanese Society of Physical Fitness and Sports Medicine (1998–2000), by the Tanaka Project of the Japanese Society of Physical Fitness and Sports Medicine (1998–2000), by the Tanaka Project (1999–2002) of TARA (Tsukuba Advanced Research Alliance) at University of Tsukuba, and by the 21st century COE (Center of Excellence) program, Ministry of Education, Culture, Sports, Science and Technology (2002–2003 Nishihira Project: Promotion of health and sport scientific research). The MicroDiet was provided by the Sunny Health Co Ltd.*

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Archives of Gerontology and Geriatrics 42 (2006) 47–58

ARCHIVES OF GERONTOLOGY AND GERIATRICS

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# Effects of cognitive function on functional decline among community-dwelling non-disabled older Japanese

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Received 6 February 2005; accepted 1 June 2005
Available online 2 August 2005

**Abstract**

This study examined whether cognitive impairment, falls, and urinary incontinence (UI) were independent predictors of functional decline using a 2-year observation of a non-disabled older Japanese cohort living in a community from 1999 to 2001. A total of 139 men and 214 women aged 70–94 years at the baseline who were independent in both activities of daily living (ADL) and instrumental activities of daily living (IADL) were analyzed in this study. Independent variables, such as cognitive impairment, falls, UI, and other possible factors associated with functional decline were obtained from an interview survey at the baseline. A dependent variable was functional status in ADL and IADL obtained at the time of the 2-year follow-up. During the 2-year follow-up, cognitive function was a significant predictor for both IADL dependence and ADL and/or IADL dependence. Using a group of subjects with Mini Mental State Examination (MMSE) scores of 30–27 points as a reference group, a significant correlation was identified between lower MMSE scores and an increased odds ratio for functional decline. Lower cognitive function was a significant predictor of functional decline, even among those older Japanese whose cognitive function was deemed to be within the normal range.


*Keywords:* Instrumental activities of daily living; Aged; Cognitive impairment; Follow-up studies; Japan

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doi:10.1016/j.archger.2005.06.001

## 1. Introduction

The rapid rise in the number of older Japanese in recent years means that public health policies should pay particular attention to conditions and disorders unique to the elderly. Some of the most common disorders among the elderly persons defined as "old–old (aged 75 years and older)" are jointly referred to as geriatric syndrome, which generally includes senile dementia, urinary incontinence (UI), immobility, malnutrition, pressure sores, and iatrogenic disorders (Tinetti et al., 1995; Kane et al., 1999). Geriatric syndrome is known to diminish not only the long-term quality of life, but also the physical functioning in older people (Tinetti et al., 1995). Although several studies have examined whether cognitive impairment, falls, and/or UI are independent predictors of functional decline (Stuck et al., 1999; Aguero-Torres et al., 2002), few such studies have simultaneously assessed the prevalence of these conditions among community-living older adults to address the question of whether the latter are possible predictors of functional decline (Tinetti et al., 1995). Most studies dealing with the association between geriatric syndrome and functional decline use the activities of daily living (ADL) scale instead of the instrumental activities of daily living (IADL) scale as an outcome measure (Stuck et al., 1999); the latter provides an essential basis for determining whether an elderly individual is capable of living independently in the community (Aguero-Torres et al., 2002; Sauvaget et al., 2002). Measures for preventing dependence on IADL are expected to contribute to preventing ADL dependence because IADL dependence is a predictor of ADL dependence (Spector et al., 1987; Kai et al., 1991; Strawbridge et al., 1996; Nourhashemi et al., 2001). This is because individuals with IADL limitations are more likely to regain independence than those with ADL limitations (Crimmins and Saito, 1993; Ishizaki et al., 2000a, 2004). We therefore examined whether cognitive function, UI, experience of falls affected functional decline in either IADL only or ADL and/or IADL using a 2-year observation of a non-disabled older Japanese cohort living in a community.

## 2. Subjects and methods

### 2.1. Data source and study subjects

Following approval by the Institutional Review Board of the Tokyo Metropolitan Institute of Gerontology (TMIG), the study was conducted in a village in Akita Prefecture in the northern area of Honshu, one of the four main islands in Japan. In 2000, the total population of the village was 3538. A survey was taken first in 1999 and then again 2 years later. In the autumn of 1999, a face-to-face interview survey was carried out in a community center, for subjects with difficulty reaching the center, at their homes, to obtain baseline data. Because the questions in this study contained sensitive items, including UI and cognitive function, we were careful to protect participants' privacy by using screens between interviewer–participant pairs. Of the 786 people aged 70 years and older (320 men and 466 women) living in the village in 1999, 605 (77%) participated in the survey (256 men and 349 women). The vital status of the cohort was identified in 2001, using information for the residence registration records provided by the village government. Two years after the baseline survey, and using the same method that had been used at the baseline, the subjects were surveyed again in relation to their survival status, ADL, and IADL. We limited the subjects of this particular study to those who were independent in both ADL and IADL at the baseline survey.

### 2.2. Assessment of functional status

ADL questions included walking, feeding, bathing, using the toilet, and dressing. IADL questions were derived from the instrumental self-maintenance scale of the TMIG index for competence (Koyano et al., 1991), and included going out using public transportation, shopping for daily necessities, preparing meals, paying bills, and depositing or withdrawing money from a bank account. The response to each item of these indices was simply "yes" (able to do without the help of another person or special equipment) or "no" (unable to do without the help of another person or special equipment). In this study, only those subjects who were assessed as being independent in all ADL (or IADL) items listed above were regarded as being ADL (or IADL)-independent. All other subjects were defined as ADL (or IADL)-dependent. Because the objective of this study was to examine the effects of geriatric syndrome on functional decline among older people during the 2-year follow-up period, we used functional status obtained from the follow-up survey conducted in 2001 as the outcome. Each subject's degree of functional independence at the time of the 2-year follow-up was categorized into the following three levels: independent in both ADL and IADL, dependent in only IADL, and dependent in ADL. In this study, functional decline was defined a change from independent in both ADL and IADL to either dependent in only IADL or dependent in ADL.

### 2.3. Assessment of geriatric syndrome

We collected information about the presence of UI, cognitive impairment, or experience of falls as geriatric syndrome. The questions regarding UI were related to the presence of UI and the frequency of incontinent episodes. The first UI question asked whether the subject had ever experienced urinary leakage before reaching a toilet. Answer choices for this question were: never, occasionally, and wearing diapers at all times. All subjects who chose alternatives indicating that they experienced urinary leakage occasionally or that they wore diapers at all times were questioned about the frequency of incontinence episodes. The answer choices were: almost daily, once every 2 days, once or twice a week, 1–3 times a month, and several times a year. Those subjects indicating that they experienced urinary leakage more than once a week were defined as having UI.

The Japanese version of the Mini Mental State Examination (MMSE) (Otsuka and Homma, 1991) was modified to evaluate the cognitive function of subjects living in a community (Folstein et al., 1985). The contents of the modified Japanese MMSE differ from the original in several ways. First, while the orientation question in the original version asks about the name and floor of the hospital where a respondent receives treatment, the same question in the modified version asks about the name of the community center where the interview was carried out. Second, the serial-sevens test, wherein the respondent starts with the number 100 and proceeds downward by subtracting seven each time, was replaced by a backward spelling of the Japanese word "*FU-JI-NO-YA-MA*" (a five-syllable Japanese word "Mt. Fuji"). This substitution was made because of difficulty encountered explaining the rules of a serial-sevens test to both interviewers and respondents. Third, a copying task (copying of a complex figure) was given before a writing task because it was expected that many of the respondents in the present survey may not have immediately understood what exactly they were expected to write when asked to write a sentence. An MMSE score of 23 points or less and a score of 19 points or less were considered to be indicative of low cognitive skills and very low cognitive skills, respectively (McDowell and Newell, 1996).

The question regarding falls asked the subjects if they had experienced any falls during the past year. All subjects who had experienced falls were then asked about the frequency of falls during that period of time.

### 2.4. Potential predictors of functional decline

The interview also included questions regarding potential predictors of functional decline: age, gender, educational status, presence of visual impairment, presence of hearing impairment, intellectual activity, social role, and self-rated health. In terms of educational status, the subjects in the present study were divided into those with 6 years of education or less (elementary school level), and those with 7 years of education or more. A question about visual impairment was asked "Do you have any difficulties with visual activities?" The answer choices were: No, Yes, Yes with glasses. A question about hearing impairment was asked "Do you have any difficulties with hearing capability?" The answer choices were: No, Yes, Yes with a hearing device. Subscales derived from the TMIG index for competence (Koyano et al., 1991) were used to assess the subjects' intellectual activity (four items: filling out pension forms, reading a newspaper, reading books or magazines, and being interested in news stories or programs dealing with health) and social role (four items: visiting the homes of friends, being called on for advice, being able to visit sick friends, and initiating conversations with young people). A subject's intellectual activity and social role were defined as "good" only if a subject was assessed as being independent in all subscale items, and were defined as "poor" if a subject was assessed as being dependent in any of the subscale items. A question about self-rated health was asked "How would you rate your present health?" The answer choices were: good, fair, poor, and very poor. In this particular study, the self-rated health was categorized as either 'good' (good or fair) or 'poor' (poor or very poor).

### 2.5. Statistical methods

Functional and cognitive status of the subjects at the baseline survey were categorized according to the level of functional independence. Possible predictors of functional decline were examined by conducting the $\chi^2$-test and a backward-stepwise multiple logistic regression analysis using either functional decline in only IADL or functional decline in ADL and/or IADL after 2 years (reference category: remaining independent in both ADL and IADL after 2 years) as a dependent variable, and presence of UI, cognitive function and experience of falls as explanatory variables. Other explanatory variables used included age, gender, educational status, presence of hearing impairment, presence of visual impairment, self-rated health, intellectual activity, and social role. Whereas a $P$-value of 0.15 was used for variable retention for the backward-stepwise procedure, gender, age, cognitive function, presence of UI, and fall experience were always used as independent variables regardless of $P$ values. The association between functional decline and possible predictors was assessed by odds ratio (OR) and 95% confidence interval (CI). We performed the goodness-of-fit tests developed by Hosmer and Lemeshow on the final model to measure how well the model fit the data (Hosmer and Lemeshow, 1989). A sensitivity analysis was conducted to determine the effects of drop-outs on the analysis results (Heitjan, 1997). Other sensitivity analysis was performed to examine the effect of the absence of the variable regarding educational attainment on the results. All analytical procedures were performed using SPSS Version 10.0 (SPSS Inc., 1999). All reported $P$ values were two-tailed, and the level of significance was $P < 0.05$.

## 3. Results

### *3.1. Functional and cognitive status of the followed-up subjects at the baseline*

Of all the subjects who participated in the 1999 baseline survey, a total of 526 (204 men and 322 women) provided answers for all question items related to functional abilities and the presence of geriatric syndrome. Of those, 81% (425 respondents) were assessed as both ADL- and IADL-independent, 14% were assessed as IADL-dependent only, and 5% were assessed as ADL-dependent.

The mean MMSE scores of 407 subjects who were both ADL- and IADL-independent at the baseline was 26.2 points (standard deviation = 3.6, median = 27, and range = 11–30). Table 1 illustrates the distribution of the subjects' MMSE scores, the proportion of subjects who experienced UI more than once a week, and the proportion of subjects who experienced falls during the past year.

### *3.2. Changes in functional independence during the 2-year interval*

Those subjects who were both ADL- and IADL-independent at the baseline were examined for changes in functional independence during the 2-year period (Table 2). Because 18 of 425 subjects did not have a clear educational status, the following analyses were conducted among 407 subjects. Of the 407 subjects who were initially independent in both ADL and IADL (163 men and 244 women), two had died during the interval between the two surveys and 55 (29 men and 31 women) did not participate in the follow-up survey. Although we did not have the detailed information on the reason for the lost to follow-up among the cohort, we confirmed that the reason was neither migration nor death. Although the majority of the surveyed subjects maintained functional independence over the 2-year period, a certain degree of functional decline was observed among 11% of the male and female subjects. Less than half of the female subjects who were aged 80 years and older remained functionally independent over the 2-year period.