

表2 低栄養指標

1) 身体計測

体重減少率

(平常時体重－現在の体重) ÷ 平常時体重 × 100 (%)

期間 軽度～中等度 中等度以上栄養障害

1 カ月	5%未満	5%以上
3 カ月	7.5%未満	7.5%以上
6 カ月	10%未満	10%以上

triceps skin fold thickness, TSF (上腕三頭筋皮膚脂肪厚)

midupper arm circumference, AC (上腕周囲長)

midupper arm muscle circumference, AMC (上腕三頭筋周囲長) = AC - π (円周率) × TSF

midupper arm muscle area, AMA (上腕筋面積) = AMC² ÷ 4π

日本人年齢別標準値を基準とする*

標準値の60%未満	高度栄養障害
60～80%未満	中等度
80～90%未満	軽度
90%以上	正常

2)

血液データ

低栄養基準値

半減期

アルブミン	3.5 g/dL 未満	17～23 日
プレアルブミン(トランスサイレチン)	10 mg/dL 未満	1.9 日
トランスフェリン	200 mg/dL 未満	7～10 日
レチノール結合蛋白	3.0 mg/dL 未満	0.5 日
血清総コレステロール	150 mg/dL 未満	

*日本人の新身体計測基準 JARD 2001. 栄養一評価と治療 2002:19(Suppl).

低栄養リスクと関連する重要評価因子

栄養状態のみの評価だけでなく、その要因を明確にするための評価項目を組み込むことが望ましい。高齢者に特有と思われる、栄養アセスメントに組み込むべき課題を挙げる。

1. 嚥下機能障害

脳血管障害、神経変性疾患、認知症などを抱える要介護高齢者では、嚥下機能に問題があるケースが多い。また、長期間経口摂取をしないことによる嚥下に関わる筋肉の廃用による嚥下機能障害も稀ではない。このような高齢者は十分な経口摂取ができず、低栄養に容易に陥り、さらには多くの場合頻回に誤嚥性肺炎を起こし、代謝性ストレスが増加し低栄養を促進させる。経口摂取を開始する際、さらには摂取時にむせ

を経験する高齢者、誤嚥性肺炎を起こした高齢者では必ず嚥下機能評価が必要となる。

2. 薬剤

高齢者では一度に多くの疾患を抱えており、種々の医療施設または種々の科で多くの薬剤が投薬されているケースが稀ではない。5～6種類以上の薬剤の服薬を polypharmacy (多剤投与) と呼ぶが、これ自体高齢者にとって低栄養 (食欲不振) のリスクになり得る。特に NSAID、ジギタリス製剤、降圧薬 (Ca拮抗薬)、テオフィリン製剤、抗うつ薬、抗精神病薬などが投与されている場合、食欲不振の有無に注意が必要である (表3)。アルツハイマー型認知症に投与されるドネペジルなどのアセチルコリンエステラーゼ阻害薬も、食欲不振を引き起こすことは稀ではない。また H₂ ブロッカー、PPI など胃酸分泌抑制薬の長期投与はカルシウム、ビタミン

表3 食欲低下に関与する可能性のある薬剤

ジキタリス製剤
 降圧薬(Ca拮抗薬)
 テオフィリン製剤
 SSRI(selective serotonin reuptake inhibitor:抗うつ薬)
 NSAID
 ビタミンD製剤(高用量)
 鉄剤
 H₂ blocker
 ほとんどの抗生物質
 ドネペジルなどのアセチルコリンエステラーゼ阻害薬
 抗精神病薬

B₁₂、鉄、亜鉛などの吸収を抑制する。

3. ADL

ADLの低下は明らかに高齢者の栄養障害の危険因子の1つである。特にADL障害のある独居高齢者では何らかのサポートがなければ、低栄養障害に至るリスクが極めて高い。したがって、高齢者の栄養アセスメントにはADL評価が不可欠である。またわれわれの調査でも、要介護認定を受けてデイサービスを使用している高齢者では、要介護度が悪くなるに従って低栄養状態が増加する⁹⁾。したがって、高齢者栄養評価時にはADL障害の有無、要介護状態の有無を把握しておく必要がある。

4. 認知症

アルツハイマー病などの認知症は、75歳以上の後居高齢者で高頻度に出現する。アルツハイマー病などの認知症は、病気の進行に従い栄養障害が出現することはよく知られた事実である。早期の栄養介入により栄養障害はある程度予防できるとの報告もあり、認知症を見逃さないことが重要である。

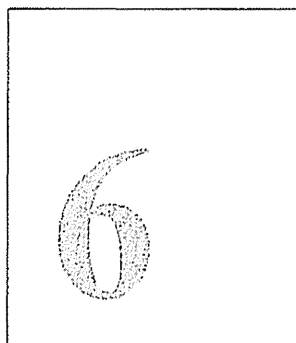
5. うつ

高齢者では驚くほど抑うつ状態が多いことが知られている。われわれの検討でも、介護保険サービスを使用している在宅高齢者で「うつ」が疑わしい対象者は57%にも及んだ¹¹⁾。しかもほとんどが未治療であった。原因不明の食思不振、体重減少は「うつ」の存在を疑う必要がある。

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サルコペニアと栄養

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要旨 加齢とともに骨格筋量が減少するが、極度に低下する現象をサルコペニアと称し、高齢者のふらつき、転倒・骨折、虚弱状態との関連で、昨今重要視されてきている。その要因はさまざまな仮説が提唱されているが、栄養、とくにタンパク質摂取量の低下が大きな要因として注目され、最近では介入研究も報告されてきている。さらにはビタミンDなどとの関連も最近注目されてきており、今後十分な栄養と適度な運動を励行することにより、サルコペニア予防が期待されている。

〈Key point〉

はじめに

サルコペニアは「加齢に伴う筋力の低下、または老化に伴う筋肉量の減少」を指し、Rosenbergにより提唱された比較的新しい造語である。一般的に70歳までに20歳代に比較すると骨格筋面積は25~30%、筋力は30~40%減少し、50歳以降毎年1~2%程度筋肉量は減少するといわれている。サルコペニアの存在は、高齢者では「ふらつき」「転倒」、さらには「虚弱 (frailty)」に密接に関連し、その先には要介護状態が待ち受けている¹⁾。したがってサルコペニアの原因を究明し、それに沿った介入法を開発、導入することは超高齢社会に突入したわが国においては、介護予防の観点からも医療・介護政策上の観点からもきわめて重要である。サルコペニアの発症機構に関しては他稿で詳細に述べられると思うので、本稿では栄養に特化して述べたいと思う。

Key words: 栄養, タンパク質, アミノ酸, ビタミンD

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I. サルコペニアのメカニズム，とくに栄養との関連

1. タンパク質とサルコペニア

筋肉タンパクの合成能

筋肉タンパクはさまざまな状況下で分解していくため，筋肉量を維持するためには筋細胞内でのタンパク合成が必須である．筋肉タンパクの合成にはその原料となるアミノ酸が必須であり，さらにその上流にあるタンパク質の摂取が必須である．加齢とともに摂取したタンパク質が効率的に使用されないのではないかと，すなわち筋肉でのタンパク合成は加齢とともに低下するのではないかと報告も以前は認められたが，現在では少なくとも多くの健康な高齢者では，若年者と同様に筋肉でのタンパク合成能は変化がないという見解が一般的である．しかし，アミノ酸摂取に対しての筋肉のタンパク同化反応の感受性が低下しているとの報告はある．

タンパク必要量

人間の必要タンパク量は19歳以上で一律に体窒素平衡から推定された0.8 g/kg(体重)/dayが推奨されており，窒素バランスからみて高齢者と若年者での体重当りのタンパク質必要量には相違がないとされている²¹．しかし，実際には高齢者ではタンパク摂取量は20～40%程度推奨量より少ないとされる．摂取タンパクを増やすことだけで筋肉量が増加するかどうかは議論があるところだが³¹，減少を予防することはできる可能性がある．地域高齢者の観察研究〔the Health, Aging, and Body Composition (Health ABC) Study〕では摂取カロリー当りのタンパク質量により3年後の除脂肪体重ならびに四肢除脂肪体重の低下率が変化しタンパク質摂取が多いほどその低下率が低いことが報告された⁴¹．四肢の除脂肪体重（骨格筋量）も同様な結果である⁴¹．これ以上にタンパク質摂取を増加させたらどうなるか興味があるが少なくとも0.7～1.1 g/kg/dayまでは直線的に除脂肪体重の減少は抑えられている．

タンパク質摂取量と除脂肪体重

一方，高タンパク質の摂取による体への悪影響（腎毒性など）が指摘されているが，腎疾患がない場合には極端な高タンパク食でないかぎり（2.0 g/kg/dayまで），重大な副作用につながることはまれである．実際，筋肉量の減少をきたしやすい高齢者が筋肉量を維持するには0.8 g/kg/dayでは不十分で，1.0～1.3 g/kg/day程度の摂取が必要との指摘もある．欧米からの報告では1.6 g/kg/dayのタンパクで運動による筋肉量増加を認めたとか，1.0 g/kg/dayが筋肉量の低下を予防する最低限のタンパク質摂取量だなどの報告もある^{21,51}．

筋肉量を維持するのに必要なタンパク質摂取量

現在，日本人の食事摂取基準では高齢者でも成人と同様，男性で推定平均必要量を50 g/day，推奨量を60 g/day，女性で推定平均必要量を40 g/day，推奨量を50 g/dayとしているが，これは0.85 g/kg/dayを推定必要量と考えての値である⁶¹．この推奨量では高齢者のサルコペニアを予防できない可能性が

あり、今後エビデンスの蓄積とともに、考え直す時期にきているかもしれない。

2. アミノ酸とサルコペニア

必須アミノ酸

正常な筋肉タンパク代謝のためにはアミノ酸の筋肉への供給が不可欠である。アミノ酸は体内で合成できるか、できないかにより非必須アミノ酸と必須アミノ酸に分けるが、筋肉のタンパク同化作用はおもに必須アミノ酸によることが知られる。筋肉を構成しているアミノ酸のうち30~40%が必須アミノ酸であるともいわれている。必須アミノ酸がなぜ筋肉においてタンパク同化として機能するかはなお十分解明されていないが、必須アミノ酸の供給は単にタンパク質合成の原料として使用されるだけでなく筋肉細胞に直接働いてタンパク質合成を刺激している可能性がある。

分枝鎖アミノ酸
ロイシン

必須アミノ酸のなかでも分枝鎖アミノ酸（ロイシン、イソロイシン、バリン）、さらにはそのなかでもロイシンがタンパク合成刺激が強いことが知られる⁷⁾。分枝鎖アミノ酸はそれ以外に筋肉エネルギー源となる唯一のアミノ酸でもある。必須アミノ酸であるロイシンによる介入の多くは体タンパク合成の増加や除脂肪体重の増加に成功している。ロイシンは70-kDa ribosomal protein S6 kinase (p70S6K) や eukaryotic initiation factor 4E binding protein-1 (4E-BP1) を含む the mammalian target of rapamycin (mTOR) pathway を介してタンパク同化作用を示すことが知られる（図1）。mTORの活性化経路として最近 Rag (a small subfamily of GTPases), MAP4K3 (a germinal center kinase-related kinase), 並びに Vps34 [a phosphatidylinositol 3 (PI3) kinase] などの経路が報告されている⁸⁾。

mTORの活性化経路

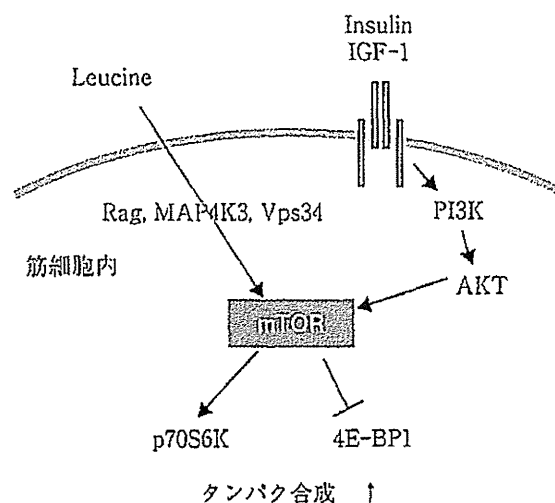


図1 ロイシンの筋肉内でのタンパク同化機構

ロイシンのタンパク同化作用と年齢

一方、高齢者では若年者と比較しロイシンのタンパク同化作用が低下しているとの報告がある。その機構としては高齢者での骨格筋では若年者と比較し mTOR 並びにその下流の S6K の経路が低下しているといわれている。しかし、十分量のロイシンに対してはタンパク同化作用は健在で筋肉タンパク質の合成に傾く。このことは高齢者の骨格筋ではロイシンが低用量だとそのタンパク質同化の刺激が弱くタンパク合成に働かない可能性がある。しかし、十分量のロイシンが加えられれば若年者と同様にタンパク合成が増加することを意味する。

3. β -hydroxy- β -methylbutyrate (HMB) とサルコペニア

HMB

ロイシンはおもに肝臓外で可逆的アミノ基転換反応により α -ketoisocaproate (KIC) に変換される (図 2)⁹⁾。KIC は肝臓内の KIC deoxygenase によりその 5% 程度が HMB に転換される。その他 95% はミトコンドリアの dehydrogenase enzyme により isovaleryl-coenzyme A (CoA) に転換される。HMB は β -hydroxy- β -methylglutaryl-CoA (HMG-CoA) に転換され、最終的にはコレステロール合成につながる。

近年、ロイシンの上記作用の少なくとも一部は、その代謝産物である、HMB が担っている可能性が示唆されている。実際、高齢者を対象に HMB 単独またはアルギニン、リジンとのコンビネーションによる介入試験がいくつか実施されているが、歩行速度などの身体機能の向上、筋力の増強効果が報告されている^{10), 11)}。そのメカニズムは十分解明されていないが、ロイシ

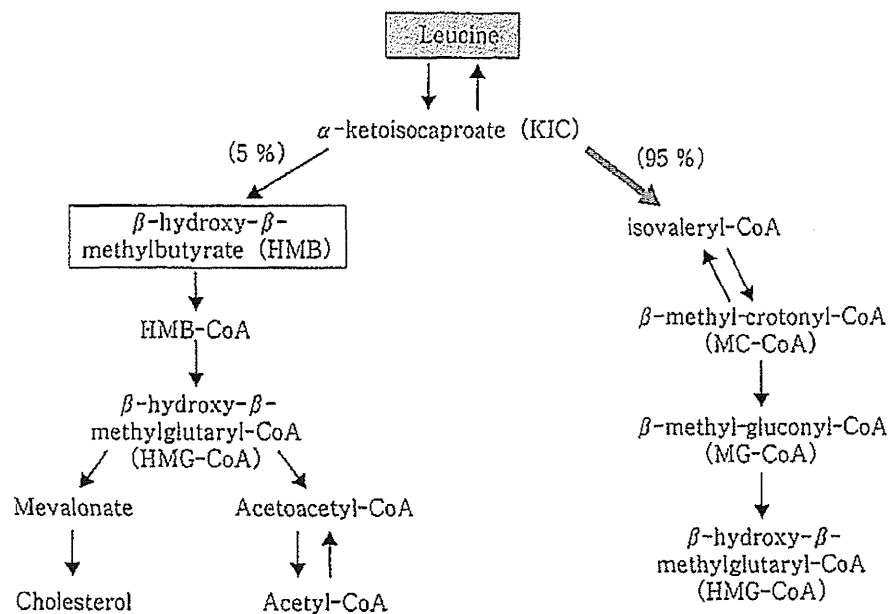


図 2 β -hydroxy- β -methylbutyrate の代謝経路

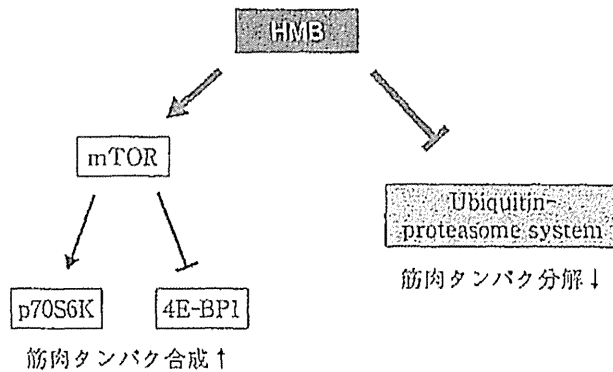


図3 β -hydroxy- β -methylbutyrate の筋タンパク増加機構

ンと同様 mTOR 経路の活性化を介して筋肉タンパクの合成の促進のみならず, ubiquitin-proteasome を介する分解亢進が抑制されることが関わっているとされている (図3)⁹⁾.

II. 運動と栄養

レジスタンス運動

運動, とくにレジスタンス運動のサルコペニアに対する効果がいくつか報告されている。しかし, 空腹時での運動では筋肉でのタンパク合成は誘導されるが, 同時に分解も促進されることが報告されており, 十分なタンパク質の供給がレジスタンス運動にも必要である¹²⁾。上でも述べたが, 報告によると, 高齢者で運動とともに 1.6 g/kg/day のタンパク質摂取で筋肉量の増大を認め, 最低限 1.0 g/kg/day のタンパク質摂取が必要とされている^{3), 5)}。

III. ビタミン D

ビタミン D とサルコペニア

高齢者ではビタミン D 欠乏に陥りやすい。ビタミン D 血中濃度とサルコペニアとの関連は横断的のみならず縦断的研究でも報告されている。たとえば 65 歳以上の高齢者で 25-hydroxyvitamin D の値と 3 年後のサルコペニアの存在との関係を検討すると, ビタミン D が低値であるとサルコペニアのリスクが増加する¹³⁾。ビタミン D は 1,25(OH)D 核内受容体を介してカルシウム・リン輸送, リン脂質代謝, 筋細胞の増殖・分化に影響を与えることが知られている。一方, ビタミン D による筋力の増強, 転倒予防に関する介入試験の結果は一致していない¹⁴⁾。しかし, 最近のビタミン D 低値の高齢者を対象とした介入試験では筋力, 転倒に対して良好な効果が報告されている¹⁵⁾。今後さらなるデータの蓄積が期待される。

おわりに

このように栄養とサルコペニアは密接に関連しているが、まだまだデータの蓄積は不十分であり、さらなる今後の研究が必要である。

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Summary

Nutrition and sarcopenia

Masafumi Kuzuya*

Prevention of sarcopenia (age-related losses in muscle mass and strength) is vital to protecting physical capabil-

ities in old age and to enable patients to live independently. Although the exact mechanisms leading to sarcopenia remain unknown, existing evidence indicates the potential importance of diet which ensure sufficient intake of protein, amino acids, and vitamin D. Epidemiological studies suggest that insufficient intake of these nutrients are common in the elderly. Although much of this evidence is observational, the prevalence of low nutrient intake and poor economic status in older adults make this a concern for health care providers. Muscle mass and strength levels in later life are a reflection of both rates

of muscle loss and optimum levels attained in early life. Therefore, efforts to prevent sarcopenia must also be made in consideration of diet during the life of the patient, as well as and the potential effectiveness of early intervention. Optimising protein and nutrition intake, along with adequate lifelong exercise may be keys to preventing sarcopenia and providing physical ability in old age.

Key words : nutrition, protein, amino acid, vitamin D

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ご案内

information

第10回「腎臓・透析医のための臨床研究デザイン塾」受講者募集要項

臨床研究を学びたい腎臓・透析医の皆さまへ

わが国の腎臓・透析医療分野において臨床家による質の高い臨床疫学研究、アウトカム研究、ヘルスサービス研究が多く発信されることを推進するため、これをキャリアとする若手研究者を育成することを目的とし、臨床研究を初歩から学べるセミナーを開催します。(6月開催「てらこ屋セミナー」も合わせてご覧ください。)

日程：2013年9月19日(木)～9月23日
(月・祝)5日間合宿形式

開催地：静岡県伊東市

定員：8名程度(申込多数の際は選考実施)

参加費：60,000円

対象：5日間全日程に参加可能で、弊機構所定の参加承諾書を提出できる方。

臨床経験満5年以上かつ40歳未満(2013年4月1日現在)で、腎臓・透析領域の診療と研究に従

事し、下記セミナーのいずれかに全日程ご参加いただいた方。

- ・2011年5月28～29日開催「第1回腎臓・透析・泌尿器領域のための臨床研究てらこ屋セミナー」
- ・2012年5月19～20日開催「第2回腎臓・透析医のための臨床研究てらこ屋セミナー」
- ・2013年6月15～16日開催「第3回腎臓・透析医のための臨床研究てらこ屋セミナー」

募集期間：2013年6月17日～7月15日

申込詳細：iHope ホームページ (<http://www.i-hope.jp/>)にてご案内いたします。

主催、問合せ：認定NPO法人健康医療評価研究機構 (iHope International) iHope イベント事務局
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老年内科入院患者における MNA-SFによる栄養評価と摂食嚥下状態 ならびに各種身体計測との関連の検討

田中 文彦¹⁾ 葛谷 雅文²⁾

1. 緒言

高齢入院患者の約40%では蛋白質の欠乏とエネルギーの欠乏が複合しておこるProtein-Energy Malnutrition (PEM)を呈すると報告されており¹⁾, 栄養不良のリスク要因である摂食嚥下機能低下や痩せの評価及び対策は重要である。今回我々は大学病院老年内科入院患者に対して簡易栄養評価ツールであるMini Nutritional Assessment Short Form (以下, MNA-SFと略)²⁾を実施し, 対象者の栄養評価と摂食嚥下状態ならびに各種身体計測との関係を検討した。

2. 方法

2010年5月18日から2011年8月10日の期間に調査可能であった名古屋大学医学部附属病院老年内科入院患者100名(65歳以上, 男性:49名, 女性:51名, 平均年齢 \pm SD:81.4 \pm 6.6歳)を対象とした。

本研究で使用した検討項目は入院1週間以内に看護師より行われた入院時摂食嚥下評価, 同じく入院1週間以内に管理栄養士より行われたMNA-SF及び各種身体計測である。入院時摂食嚥下評価は当院独自のもので, (1)飲み込みにくさ, (2)口腔内食物残留, (3)痰がらみ, (4)咽頭食物残留, (5)むせ込みの5項目の問診を, それぞれ「よくある」, 「ときどきある」, 「ない」

に分類するものである。今回の検討では(1)~(5)のすべての問診で「ない」に分類されている場合を摂食嚥下状態「問題なし」, (1)~(5)のすべての問診に「よくある」もしくは「ときどきある」が一つでもある場合を摂食嚥下評価「障害あり」, 評価を行える状態ではなかった場合を摂食嚥下評価「評価不可能」とした。また, 各種身体計測は, インサーテープ[®], 簡易キャリパー[®](いずれもアボットジャパン株式会社)を用いて上腕周囲長(arm circumference:AC), 上腕三頭筋皮下脂肪厚(triceps skinfold thickness:TSF), 下腿周囲長(calf circumference:CC)を計測し, AC及びTSFから上腕筋囲(arm muscle circumference:AMC)と上腕筋面積(arm muscle area:AMA)を算出した。これら各種計測結果と「日本人の新身体計測基準値(Japanese anthropometric reference date 2001:JARD2001)」³⁾に記された年齢・性別ごとの中央値から%TSF・%AC・%CC・%AMC・%AMAを算出した。MNA-SF評価群と摂食嚥下評価の結果ならびに各種身体計測(%)との関係について検討を行った。

3群間の比較にはカイ2乗検定, もしくは一元配置分散分析を用いた。解析にはSPSS18.0を用い, $p < 0.05$ を統計的有意とした。

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図表 1 対象者の特性

	MNA-SF			p
	良好群 (n=24)	risk群 (n=46)	低栄養群 (n=30)	
男/女(n)	8 / 16	25 / 21	16 / 14	ns
年齢(歳)*	79.2±7.1	80.7±6.0	81.4±6.1	p=0.011
MNA-SF (range:0-14)*	13.0±0.9	9.7±1.1	4.7±1.8	p<0.001
摂食嚥下評価(n)				
問題なし	24	38	11	p<0.001
障害あり	0	5	10	
評価不可能	0	3	9	
身体計測*				
TSF (cm)	1.4±0.6	0.9±0.4	0.7±0.4	p<0.001
%TSF (%)	116.6±47.7	80.5±37.7	70.3±32.7	p<0.001
AC (cm)	26.8±3.2	24.0±3.2	22.5±2.9	p<0.001
%AC (%)	109.2±14.4	96.9±14.0	92.8±13.0	p<0.001
CC (cm)	33.2±3.8	30.4±3.5	27.5±2.6	p<0.001
%CC (%)	107.9±10.8	98.1±11.3	90.6±8.8	p<0.001
AMC (cm)	22.5±2.6	21.2±2.6	20.2±2.4	p=0.006
%AMC (%)	108.8±12.7	100.5±13.9	97.2±12.5	p=0.007
AMA (cm)	40.9±9.7	36.3±8.9	33.1±8.1	p=0.007
%AMA (%)	120.4±30.8	103.1±29.9	96.4±27.1	p=0.012

* Mean ± SD

ns : not significant

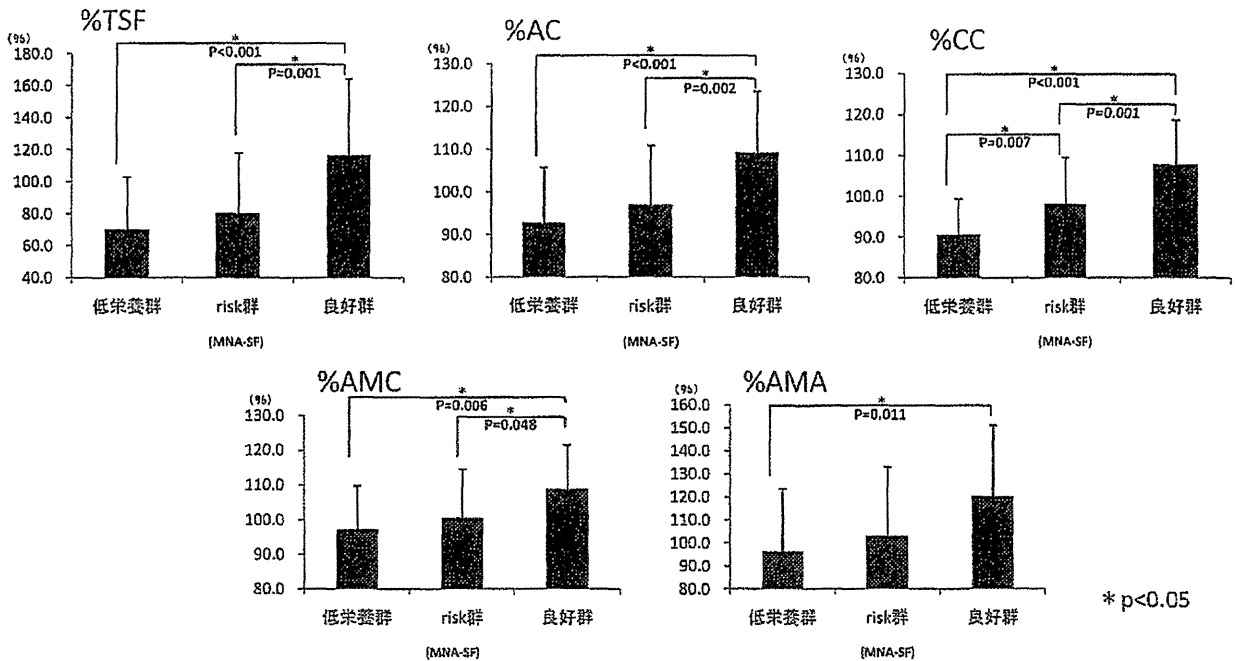


図 1 NMA-SF と各種身体計測 (%)

3. 結果

対象者の特性を表 1 に示した。

MNA-SF の結果は「栄養状態良好」が 24 名 (以下、

良好群), 「At risk」が 46 名 (以下, risk 群), 「低栄養」が 30 名 (以下, 低栄養群) で, 良好群は全体の 24% に留まった。摂食嚥下評価の結果, 「問題なし」が 73 名, 「障害あり」が 15 名, 「評価不可能」が 13 名であった。

MNA-SF 評価群と摂食嚥下評価の結果を比較検討すると、MNA-SF 良好群では摂食嚥下評価結果「問題なし」が24名(100%)、「問題あり」及び「評価不可能」はともに0名であった。また、MNA-SF risk群では摂食嚥下評価「障害有り」が5名(11%)、「評価不可能」が3名(7%)、MNA-SF 低栄養群では摂食嚥下評価結果「障害有り」が10名(33%)、「評価不可能」が9名(30%)となった。

MNA-SF 評価群と JARD2001 より算出した各種身体計測 (%) との検討では、MNA-SF 良好群でのすべての各種身体計測 (%) の平均は100%を超えていた。また、MNA-SF 良好群、risk群、低栄養群での各種身体計測 (%) の平均は、すべてで良好群 > risk群 > 低栄養群との結果となり、図1より良好群と低栄養群にはすべてで有意な群間差 ($p < 0.05$) を認めた。

4. 考 察

本研究では、大学病院急性期病棟での高齢入院患者に対して入院時栄養評価、摂食嚥下評価、各種身体計測について調査を行った。

今回の検討では、MNA-SF 評価で「低栄養」と評価された割合は30%、「At risk」と評価された割合は46%と高率に栄養の問題がある患者が存在していた。MNA-SF の平均値が低値で栄養不良と判定されると、摂食嚥下障害がある群が高率となり、また、%TSF、%AC、%CC、%AMC、%AMAのすべての各種身体計測 (%) の平均値が低値となる傾向が認められた。これらのことより、高齢患者に対して入院時にMNA-SFを実施することで、摂食嚥下機能ならびに身体状態のリスクを予想し、早期に管理栄養士、言語聴覚士、摂食・嚥下障害看護認定看護師などが介入することによって、食事形態の調整や投与栄養量の検討などが可能になると思われる。したがって、MNA-SFによる高齢入院患者の栄養評価は極めて重要であり、今後も継続した使用が望まれる。

最後に、本研究では入院時摂食嚥下評価を病棟看護師が行っており、客観的かつ定量的な嚥下機能を基盤とした評価ではないため、嚥下障害の判断が適切でない可能性があることは本研究の限界である。

5. 結 語

今回の検討により、MNA-SF と摂食嚥下状態ならびに身体計測との間には、密接な関係があることが示唆された。今後は入院時だけでなく、在院中や退院時の栄養・摂食嚥下評価、各種身体計測を実施して、経時的な検討を行っていきたい。

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ORIGINAL ARTICLE: BEHAVIORAL
AND SOCIAL SCIENCES

Day-care service use is a risk factor for long-term care placement in community-dwelling dependent elderly

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Aims: To identify predictors of long-term care placement and to examine the effect of day-care service use on long-term care placement over a 36-month follow-up period among community-dwelling dependent elderly.

Methods: This study was a prospective cohort analysis of 1739 community-dwelling elderly and 1442 caregivers registered in the Nagoya Longitudinal Study for Frail Elderly. Data included the clients' demographic characteristics, basic activities of daily living, comorbidities, and use of home care services, including the day-care, visiting nurse, and home-help services, as well as caregivers' demographic characteristics and care burden. Analysis of long-term care placement over 36 month was conducted using Kaplan-Meier curves and multivariate Cox proportional hazards models.

Results: Among the 1739 participants, 217 were institutionalized at long-term care facilities during the 36-month follow-up. Multivariate Cox regression models, adjusted for potential confounders, showed that day-care service use was significantly associated with an elevated risk for long-term care placement within the 36-month follow-up period. Participants using a day-care service two or more times/week had significantly higher relative hazard ratios than participants not using such a service.

Conclusion: The results highlight the need for effective measures to reduce the long-term care placement of day-care service users. Policy makers and practitioners must consider implementing multidimensional support programs to reduce the caregivers' willingness to consider long-term care placement. *Geriatr Gerontol Int* 2012; 12: 322-329.

Keywords: community, day-care service, elderly, long-term care placement, nursing home.

Introduction

Japan introduced a universal-coverage long-term care insurance (LTCI) program in April 2000.^{1,2} This program brought a radical change from traditional, family-based care toward elderly care involving socialization and the integration of medical care and welfare

Accepted for publication 15 September 2011.

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services. There are two types of services covered by LTCI: community-based services and institutional services. Community-based services include various programs such as the home-help service, visiting bathing service, visiting rehabilitation, day care (rehabilitation), visiting nurse service, assistive device leasing, short stays (temporary stays at nursing facilities), in-home medical care, and care management services, care services provided by for-profit private homes, and allowance for the purchase of assistive devices and home renovation. In theory, the applicant can choose any certified providers and listed services.

In practice, a major role is played by a "care manager," a licensed professional who has passed an examination and undergone brief training, who draws up a care plan and a weekly schedule of service provision for individual seniors. It is essential that the care plan must be approved by the client or the client's family, and new care managers can be requested at any time if care plans prove inadequate. The maximum amount of reimbursement in the LTCI system is capped according to the care level.^{3,4} Elderly beneficiaries pay a 10% co-payment for services received.

The aims of LTCI home care programs are to reduce the care burden of caregivers, maintain and improve the functional abilities and well-being of elderly people, and decrease the use of institutional care services and mortality. However, there is little evidence of how community-based services affect care recipients' outcomes, the subjective burden of caregivers or reduce the use of institutional care services.

The Nagoya Longitudinal Study for Frail Elderly (NLS-FE) compares outcomes of the use of different care services provided by the LTCI program; it was designed to provide a structured comparison of services and a comprehensive standardized assessment instrument.^{5,6} Day-care service, which includes "day care" and "day rehabilitation," is provided in designated centers and is one of the major LTCI community-based services. Day-care service is a facility-based daytime program of nursing care, rehabilitation therapies, supervision and socialization that enables frail, older people, who are in poor overall health and have multiple comorbidities and varying physical or mental impairments, to remain active in the community. The individual visits the facility once or several times a week and then returns to his or her own home.

Although one of the aims of day-care service is to minimize or delay the possibility of institutionalization and maximize the potential for care recipients to maintain an independent life in the community, only a limited number of studies have examined the impact of day-care service on long-term care (LTC) placement among community-dwelling older adults. Moreover, most of these studies have targeted patients with dementia. Previous studies targeting dementia have

demonstrated that day-care use is associated with nursing home placement in persons with Alzheimer's disease.^{7,8} However, the effect of using day-care service on the LTC placement of community-dwelling, frail elderly with various chronic diseases remains unknown, although it has been reported that day-care services reduce caregiving time and provide respite to caregivers.^{9,10}

In the present prospective cohort study using the NLS-FE cohort, we examined whether day-care service use among community-dwelling older people using various community-based services under LTCI in Japan influenced LTC placement during a 36-month follow-up period. Analysis of LTC placement over the 36-month was conducted using Kaplan–Meier curves and multivariate Cox proportional hazards models.

Methods

Subjects

The present study employed baseline data of the participants in the NLS-FE and data on the mortality of these patients during the 36-month follow-up. Details of participants and the NLS-FE have been published elsewhere.^{5,6} The study population initially consisted of 1875 community-dwelling dependent elderly (632 men and 1243 women, age 65 years or older) who were eligible for LTCI, lived in Nagoya City and received various home care services from the Nagoya City Health Care Service Foundation for Older People, which has 17 visiting nursing stations associated with care-managing centers. These NLS-FE participants, who were enrolled between 1 December 2003 and 31 January 2004, were scheduled to undergo comprehensive in-home assessments by trained nurses at the baseline and at 6, 12, 24, and 36 months. At 3-month intervals, data were collected about any events participants experienced, including admission to the hospital, LTC admission and mortality. Per the procedures approved by the institutional review board of Nagoya University Graduate School of Medicine, participants provided written informed consent and, for those with substantial cognitive impairment, a surrogate (usually the closest relative or legal guardian) or family caregivers provided it.

Data collection

Data were collected from standardized interviews with patients or surrogates and caregivers conducted at clients' homes and from care-managing center records by trained nurses. The data included clients' demographic information, depressive symptoms as assessed by the short version of the Geriatric Depression Scale (GDS-15),¹¹ and a rating for the seven basic activities of daily living (ADL) (feeding, bathing, grooming, dressing, using the toilet, walking, and transferring) using

summary scores ranging from 0 (total disability) to 20 (no disability).¹² The interview with participants also included questions about using care services, including day-care service, which includes day care and day rehabilitation, visiting nurse service, and home-help service programs, as well as medical services. In addition, the weekly frequency with which clients used these services was obtained.

Information obtained from care-managing center records included data on the following physician-diagnosed chronic conditions: ischemic heart disease, congestive heart failure, cerebrovascular disease, diabetes mellitus, dementia, cancer, and other diseases comprising the Charlson comorbidity index,¹³ which represents the sum of a weighted index that takes into account the number and seriousness of preexisting comorbid conditions.

Data were also obtained from caregivers concerning their own personal demographic characteristics and their subjective burden as assessed by the Japanese version of the Zarit Burden Interview (ZBI),¹⁴ which is a 22-item self-report inventory that examines the burden associated with functional behavioral impairments in the home care situation.

For the analysis, 136 of the original 1875 participants were excluded because of missing data regarding service use or confounding/intermediary variables, leaving 1739 in the analysis. Of these 1739 participants, 412 could not complete the GDS-15 because of severe cognitive impairment or communication impairment. Also, among the 1739 older participants, 1442 participants had primary caregivers. Of these 1442 caregivers, 289 could not or refused to complete the ZBI.

We defined three types of care facilities providing LTCI as LTC facilities: nursing homes, care health facilities for the elderly, and group homes for elders with dementia. We assessed LTC placement over 36 months using event reports at 3-month intervals. LTC placement was confirmed by visiting nurses or care-managing center records. Placement time was defined as the number of months (3-month intervals) between the baseline interview and the event report of LTC placement. We censored participants living at home after 36 months of follow-up ($n = 773$), at death ($n = 401$), or at dropout ($n = 248$).

Statistic analysis

The Student's *t*-test and χ^2 test were used to compare differences at baseline between users and nonusers of day-care service. To create ideal model, we first evaluated the association between each covariate and LTC placement using univariate Cox proportional hazards model. LTC placement over 36 months was estimated for each group (day-care service use once or multiple times per week, and nonusers) using the Kaplan–Meier

method. We then evaluated the impact of day-care service use and weekly frequency of service use on the overall model with a series of Cox proportional hazards models, which included gender, age, ADL status, presence or absence of dementia, and caregiver's sex, age and ZBI score. The risk of a variable was expressed as a hazard ratio (HR) with a corresponding 95% CI. All analyses were performed using the SPSS v. 11 (Chicago, IL, USA). $P \leq 0.05$ was considered significant.

Results

When the baseline characteristics were compared between day-care service users and nonusers, older age, a higher Charlson comorbidity index, and a lower GDS-15 score were observed in day-care service users than in nonusers (Table 1). Higher prevalence rates of cerebrovascular disease and dementia were also observed in day-care service users. The rates of nursing service use, home-help service use and living alone among day-care service users were lower than those of nonusers. Among caregivers' variables, the rate of male caregivers was significantly lower for day-care service users than nonusers. Higher ZBI score was detected in users' caregivers.

Among the 1739 participants, 217 participants were institutionalized at LTC facilities during the 36-month follow-up period. A higher rate of LTC placement was observed in day-care service users than in nonusers ($n = 143$, 18.5% vs. $n = 74$, 7.7%, $P < 0.001$) (Table 1). Among the 1327 participants who could complete the GDS-15, 150 participants were institutionalized at LTC facilities during the 36-month follow-up period. Of the 412 who could not perform the GDS-15, 67 were institutionalized at LTC facilities during the 36-month follow-up period. A higher LTC placement rate was observed in the participants who could not complete GDS-15 test than in those who could (16.3% vs. 11.3%, $P = 0.008$). There were no significant differences in LTC placement rate between participants living alone and those living with others (12.8% vs. 12.4%, $P = 0.802$). Furthermore, there was no significant difference in the LTC placement rate between participants living with caregivers who completed the ZBI and those who did not (13.0% vs. 11.1%, $P = 0.375$).

Cox hazard regression and Kaplan–Meier models

Table 2 shows the results of the unadjusted univariate Cox hazard regression analysis, which suggested that LTC placement within the 36-month follow-up period was associated with older age, a lower function of basic ADL, day-care service use, and the presence of dementia (Table 2). Among caregivers' variables, only higher care burden was associated with LTC placement. Figure 1A shows Kaplan–Meier curves exploring the

Table 1 Baseline characteristics of the 1739 care recipients and the 1442 caregivers

	Day-care service		P-value
	User	Nonuser	
Care recipients (<i>n</i> = 1739)			
Men/women (% of men/total)	256/518 (33.1)	319/646 (33.1)	0.994
Age, years (mean, SD) [†]	81.4 (7.7)	80.2 (7.5)	0.002
Basic ADL, range: 0–20 (mean, SD) [†]	13.0 (5.9)	13.5 (6.7)	0.099
Charlson comorbidity index, range: 0–35 (mean, SD) [†]	2.2 (1.5)	1.8 (1.6)	<0.001
GDS-15 (range: 0–15), mean (SD) ^{†‡}	6.1 (3.6)	6.8 (3.7)	0.002
Chronic diseases (% of total)			
Ischemic heart disease	12.4	12.0	0.809
Congestive heart failure	8.7	8.4	0.845
Cerebrovascular disease	42.8	27.6	<0.001
Diabetes mellitus	12.4	11.7	0.659
Dementia	44.2	22.6	<0.001
Cancer	8.0	10.1	0.142
Visiting nurse service use (% of total)	38.1	54.0	<0.001
Home-help service use (% of total)	42.4	50.5	0.001
Regular medical checkups (% of total)	55.3	60.7	0.023
Living alone (% of total)	17.3	28.1	<0.001
Hospitalization during 36-month follow-up (% of total)	42.5	41.0	0.537
Long-term care placement during 36-month follow-up (% of total)	18.5	7.7	<0.001
Caregiver variables (<i>n</i> = 1442)			
Men/women (% of men/total)	137/553 (19.9)	217/535 (28.9)	<0.001
Age (years), mean (SD) [†]	63.4 (12.3)	64.3 (12.4)	0.177
Relationship to care recipient (% of total)			
Spouse	35.4	42.8	
Child	35.8	37.1	<0.001
Daughter-in-law	25.7	15.4	
Others	3.2	4.7	
ZBI score, range: 0–88 (mean, SD) [§]	30.1 (16.8)	26.8 (17.0)	0.001

[†]Student's *t*-test, others were analyzed by χ^2 test (user vs. nonuser). [‡]GDS-15, geriatric depression scale, *n* = 1327. [§]ZBI, the Zarit Burden Interview. *n* = 1153.

association between weekly frequency of day-care service use and time to LTC placement (3-month intervals). The risk of LTC placement was higher for participants who used day-care service more frequently than those who used it less frequently.

Table 3 shows the results of the series of Cox proportional hazards models that examine the HR of day-care service use to LTC placement during the 36-month follow-up period. The sequential adjustment had minor influences on the association between day-care service use and LTC placement during the 36-month follow-up period. The HR for the fully adjusted models was 2.34 (95% CI = 1.60–3.41).

In the Cox regression model adjusted for potential confounders, participants with more frequent use of day-care service had a significantly higher relative HR than participants with less frequent use of the service (Fig. 1B). Although there was no significant association between using day-care service once per week and the

risk of LTC placement, participants using a day-care service two or more times per week had a significantly higher relative HR than participants not using the service.

Discussion

In the present study we demonstrated that day-care service use was associated with LTC placement during the 36-month study period among community-dwelling frail elderly using various community-based services under the LTCI program in Japan. Many previous studies have examined predictors of LTC placement in study samples, but these have been limited to people with dementia and there have been fewer evaluations of risk factors for LTC placement in community samples.^{15–19} Few studies have comprehensively investigated how both caregiver and recipient characteristics influence LTC placement.¹⁹ Previous observations

Table 2 Univariate Cox proportional hazards model to identify predictors of long-term care placement over 36 months

Variable	Univariate		P-value
	HR [†]	95% CI	
Care recipients (<i>n</i> = 1739)			
Men (vs. women)	0.75	0.56–1.02	0.067
Age (continuous)	1.04	1.03–1.06	<0.001
Living with someone (vs. living alone)	1.02	0.74–1.39	0.920
Basic ADL (range: 0–20) (continuous)	0.97	0.95–0.99	0.001
Regular medical checkups per month (no regular checkup)	1.19	0.90–1.56	0.214
Formal care use (vs. nonuse)			
Visiting nurse	1.15	0.88–1.51	0.295
Day-care service	2.42	1.83–3.21	<0.001
Home helper	0.71	0.81–1.37	0.714
Charlson comorbidity index (continuous)	1.04	0.95–1.13	0.375
GDS-15 (continuous) [†]	1.01	0.96–1.05	0.762
Presence of chronic diseases (vs. absence)			
Ischemic heart disease	1.02	0.68–1.53	0.926
Congestive heart failure	1.16	0.73–1.84	0.523
Cerebrovascular disease	1.00	0.76–1.32	0.986
Diabetes mellitus	0.78	0.50–1.22	0.272
Dementia	3.00	2.29–3.92	<0.001
Cancer	0.84	0.49–1.44	0.520
Hospitalization during 36-month follow-up (vs. never admitted)	1.08	0.82–1.42	0.576
Caregiver variables (<i>n</i> = 1442)			
Men (vs. women)	0.95	0.67–1.33	0.752
Age (continuous)	1.01	1.00–1.02	0.059
Character of caregiver (vs. child)			
Spouse	0.90	0.64–1.28	0.555
Daughter-in-law	1.29	0.88–1.88	0.189
Others	1.21	0.60–2.43	0.596
ZBI score(continuous) [‡]	1.03	1.02–1.04	<0.001

[†]GDS-15, geriatric depression scale, *n* = 1327. [‡]ZBI, the Zarit Burden Interview. *n* = 1153. HR, hazard ratio.

demonstrated that common risk factors of LTC placement of community-dwelling elderly were older age, presence of dementia, and caregiver's burden.^{16,18,19}

Although one of the aims of day-care service is to minimize or delay the possibility of institutionalization and maximize the potential for care recipients to maintain an independent life in the community, only a limited number of studies have examined the impact of day-care service on LTC placement among community-dwelling older adults – and most of these have targeted demented patients. Previous studies targeting dementia have demonstrated that day-care use is associated with nursing home placement in persons with Alzheimer's disease.^{7,8} We expanded the target group and demonstrated a striking association between day-care service use and the risk of LTC placement for community-dwelling dependent elderly patients with various chronic diseases, even after adjusting for the presence of dementia and caregiver's burden. We clearly showed,

after adjusting for potential confounders, that the frequency of day-care service use had a negative impact on LTC admission with the 36-month follow-up period. The use of day-care service two or more times per week negatively affected LTC placement, but there was no significant association between institutionalization and the use of day-care service once a week. It is possible that participants with more comorbidities and a more depressive mood use day-care service more frequently; thus, participants using a day-care service two or more times per week were more likely to be placed in LTC facilities. However, even if comorbidity index score and GDS-15 score were included in the analysis, the association between LTC placement and the use of day-care service two or more times per week persisted (data not shown). This contrasts with our recent report that the risk of 21-month mortality among community-dwelling elderly was reduced significantly with frequent use of day-care service.⁶ The complex decision to place older

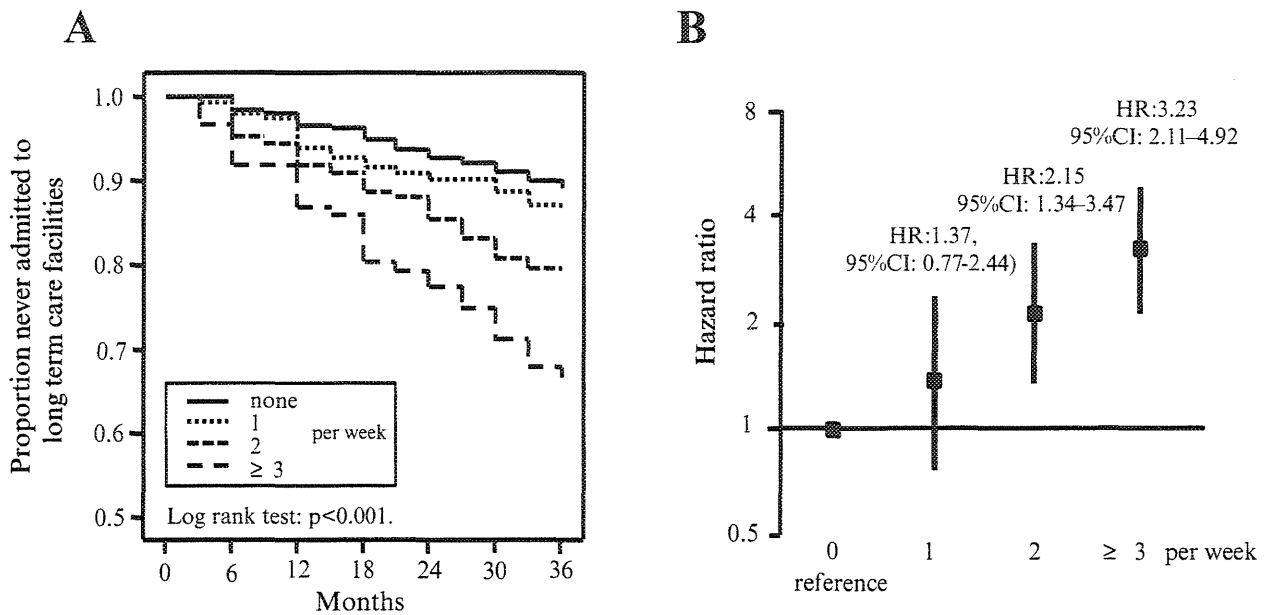


Figure 1 (A) Kaplan-Meier estimates of long-term care (LTC) placement over 36 months according to the frequency of day-care service use (times per week). The log-rank test: $P < 0.001$. (B) Risk of LTC placement based on the frequency of day-care service use (times per week), adjusting for potential confounders (recipient's gender, age, ADL status, presence or absence of dementia, caregiver's gender, age, and Zarit Burden Interview score). The y-axis is the adjusted hazard ratios (HR) on a log scale. Black squares are point estimates from a Cox proportional hazards model adjusting for potential confounders. The error bars represent 95% CI. A simple black square without confidence intervals represented the referent group, nonusers.

Table 3 Hazard ratios for long-term care placement associated with day-care service use (multivariate models)

Models	Hazard ratio	95% CI	<i>P</i> -value
Model 1 ($n = 1739$)	2.32	1.75–3.08	<0.001
Model 2 ($n = 1739$)	1.96	1.47–2.62	<0.001
Model 3 ($n = 1150$)	2.34	1.60–3.41	<0.001

Model 1 includes recipient gender and age. Model 2 includes recipient gender, age, ADL score, and presence or absence of dementia. Model 3 includes variables used in model 2 and caregiver's gender, age and Zarit Burden Interview score.

people in LTC is based on care recipient and caregiver characteristics and the sociocultural context of the recipient and caregiver. We do not know the exact reason for this negative effect of day-care service on LTC placement. There are conflicting findings in regard to the effect of day-care service on caregivers' stress, depression, subjective or objective burden, and physical and emotional well-being,^{9,10} although a recent relatively large study demonstrated that day-care service had a beneficial effect on restricting caregiving time and providing respite to caregivers.^{9,10} It is possible that day-care service alone cannot satisfy the complex needs of caregivers and care recipients sufficiently to enable continued home care, and it is unlikely to change the caregiver's preference for institutional placement.²¹ Although we still do not know whether the character-

istics of caregivers and recipients, or day-care service use itself, increase the risk of LTC placement, the relief and improved mental and physical well-being of caregivers following day-care service use may enhance the willingness of caregivers to consider LTC placement. Caregivers who use day-care service or other respite services may become more aware of their level of stress and more willing to consider LTC placement as an acceptable option, especially if the service experience is positive or if the caregiver receives encouragement to institutionalize from professionals or other caregivers.²²

This study has important limitations. First, the study was not a randomized intervention trial. Japan has introduced the LTCI program, which provides various services, including day-care services, according to clients' preferences. Therefore, we could not randomize the use

of this service. Because of the observational design of the present study, differences in unmeasured factors including the severity of patients' chronic diseases, caregivers' health conditions, and quality of services may account in part for the findings. Those who use formal services may have greater need for caregiving than those who do not use formal services. The unmeasured needs that contribute to day-care service use may be stronger than the positive effects of service. Other aspects of the present study should also be considered. In the analysis, baseline data of service use was included, but changes in service use during the follow-up period were not considered. Our results may not be representative of the Japanese frail elderly in the community as a whole because the subjects in this study represented an urban population. In addition, these findings may not be generalizable to other populations given that local health practices, a variety of social and economic factors, ethnic attitudes about caring for very old people, and cost/access to day-care centers may have influenced these results.

In the present study, we showed that day-care service does not achieve the LTCI program aim of reducing the use of institutional care services of elderly people to enable them to maintain their lives at home. It may be possible that the respite for caregivers provided by day-care service is not enough to continue caregiving at home. As is true for any observational study, we cannot firmly establish a cause-and-effect relationship between day-care service use and LTC placement. In addition, the present study could not evaluate the exact reasons for the unfavorable effect of this service on LTC placement. Further studies are needed to determine why caregiving families decide to use day-care services, reasons for LTC placement, and whether day-care services meet the needs of families and care recipients throughout the caregiving career. In addition, future research should assess the quality of day-care programs and examine whether the quality of day-care services affects the LTC placement of clients. Health-care providers and care managers should recognize that day-care service use may augment LTC placement in dependent older people. Policy makers and practitioners should consider implementing a multidimensional support program to reduce caregivers' willingness to consider LTC placement.

Acknowledgments

The authors wish to thank all the patients, caregivers and the many nurses participating in the study as well as the Nagoya City Health Care Service Foundation for Older People for its vigorous cooperation. This work was supported by a Grant-in-Aid for Comprehensive Research on Aging and Health from the Ministry of Health, Labour and Welfare of Japan and a grant from the Mitsui Sumitomo Insurance Welfare Foundation.

Disclosure statement

The authors have no conflicts of interest with any of the manufacturers of medications evaluated in this paper.

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