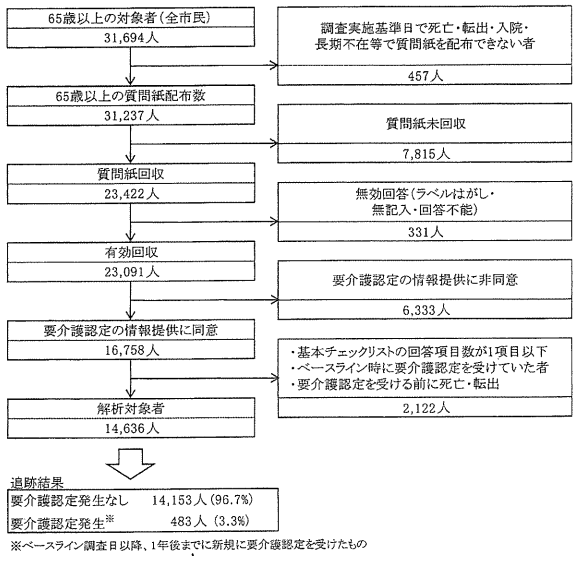
図1　対象者のフロー図



基本チェックリストの各項目や各分野の該当基準が要介護認定発生を予測し得るかを評価するために，3つの解析を行った。

第一に，多重ロジスティック回帰分析によって，要介護認定発生のリスク因子としての関連の有無と強さを評価した。目的変数は，要介護認定発生の有無とした。説明変数は，1)各項目での該当の有無，2)二次予防事業の対象者の選定の際に用いられる7分野の基準への該当の有無，3)二次予防事業の対象者の選定基準への該当の有無とした。先行研究より基本チェックリストの「該当あり」の回答が高齢になるほど多いことが予測されたため[8]，性とともに年齢を補正した多重ロジスティック回帰分析を行い，上記の説明変数について非該当者に対する該当者の要介護認定発生のオッズ比と95％信頼区間（95％CI）を推定した。さらに，1)各項目の該当の有無については，No. 1からNo. 25までを同時投入したモデルを作成し，同様にオッズ比と95％CIを推定した。

第二に，感度，特異度，陽性反応適中度によるスクリーニングの精度の評価を行った。外的基準（Gold standard）は要介護認定発生の有無とし，1)二次予防事業の対象者選定の際に用いられる7分野の基準への該当の有無，2)二次予防事業の対象者の基準への該当の有無について，感度，特異度，陽性反応適中度を算出した（区分値については「1. ベースライン時の基本チェックリストの調査」を参照）。

第三に，ROC分析の曲線下面積（Area under the curve; AUC）によるスクリーニングの精度の評価を行った。ROC分析とは検査値のいくつかの値をカットオフ値として陽性・陰性を識別し，それぞれで感度（真陽性率）を縦軸に，偽陽性率を横軸にプロットして得られたROC曲線に基づく分析である[9]。AUCはROC曲線下の面積のことであり，検査の識別能力が優れているほど，曲線は左上に偏位して，面積は大きくなる。外的基準は要介護認定発生の有無とし，現行の二次予防事業の対象者選定の際に用いられている基準の7分野の該当項目数についてROC曲線を作成し，AUCと95％CIを求め，スクリーニングツールとしての識別能力の比較を行った。

ROC分析以外の全ての解析には，SAS ver. 9.1（SAS inc, Cary, NC, USA）を用い，ROC分析にはSPSS Statistics 17.0（SPSS Inc, Chicago, IL, USA）を用いた。統計学的有意水準は基本的に$P<0.05$としたが，Bonferroniの補正によって基本チェックリスト各項目（25項目）の解析では有意水準を$P=0.002$，各分野（8通り）の解析では有意水準を$P=0.006$とした場合の結果も参照した。

4. 倫理的配慮

本調査研究は，東北大学大学院医学系研究科倫理審査委員会の承認を得た（番号2007-430　平成20年3月24日）。また対象者に対しては，調査目的を調査資料及び同意書にて説明した上で，要介護認定に関する情報提供について同意書への署名により同意を得た。

Ⅲ　研究結果

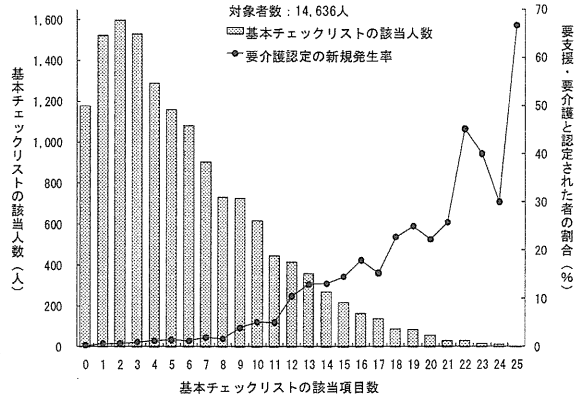
1. 基本特性および基本チェックリストの回答状況と要支援・要介護と認定された者の割合

解析に先立ち，解析対象者における選択バイアスの程度を検討するため，第一に65歳以上の全市民31,694人のうち基本チェックリストの回答が得られた者23,091人と得られなかった者8,603人を比較し，第二に有効回答者のうち要介護認定に関する情報提供の同意者16,758人と非同意者6,333人を比較した。

まず，有効回答が得られた者と得られなかった者について，性別は，有効回答者では男性41.6％，女性58.4％であるのに比べ，非有効回答者では男性37.0％，女性63.0％と，非有効回答者で女性の割合が高かった。平均年齢（標準偏差）は，有効回答者74.9（6.6）歳，非有効回答者77.1（7.9）歳であった。

次に，要介護認定に関する情報提供の同意者と非同意者について，性別は，同意者では男性43.3％，女性56.7％，非同意者は男性37.1％，女性62.9％であった。平均年齢（標準偏差）は，同意者74.9（6.6）歳，非同意者74.9（6.5）歳であった。基本チェックリスト25項目での該当項目数の平均値（標準偏差）

図2　基本チェックリストの該当項目数の分布と要支援・要介護と新規認定された者の割合



は，同意者7.0（5.7）項目，非同意者8.9（6.9）項目であり，非同意者で基本チェックリストにネガティブな回答が多かった。

解析対象者14,636人のうち，男性は6,497人（44.4%），女性は8,139人（55.6%）であった。平均年齢（標準偏差）は74.0（6.0）歳であった。また1年以内の新規の要介護認定の発生者数は，483人（3.3%）であった（図1）。1年以内の新規の要介護認定の発生者の内訳は，要支援168人，要介護315人であった。

基本チェックリストの該当項目数の分布と該当項目数ごとの1年間の要支援・要介護と新規認定された者の割合について示す（図2）。基本チェックリストの該当項目数は2項目をピークとして右に裾をひいていた。該当項目数ごとの新規認定者の割合は，基本チェックリストの該当項目数が多くなるに従って増加していた。

2.　基本チェックリストの各項目における要介護認定発生のオッズ比

基本チェックリストの回答状況と要介護認定の発生状況，および多重ロジスティック回帰分析による基本チェックリストの各項目に該当した場合の要介護認定発生のオッズ比を示す（表1）。

基本チェックリストの回答状況と要介護認定の発生状況については，No. 1～No. 25の全項目で「該当なし」の者に比べて「該当あり」の者で，新規認定者の割合が高かった。中でも該当率が高かったのは，「10)転倒に対する不安は大きいですか」や「13)半年前に比べて固いものが食べにくくなりましたか」であるが，この2項目は他の項目と比べて特に新規認定者の割合が低かった。

性・年齢を補正したモデルによる解析の結果，No. 1～No. 25の全項目で有意なオッズ比の上昇を認めた（オッズ比の範囲：1.45～4.67）。なお基本チェックリストが25項目からなることを考慮し，Bonferroniの補正によって有意水準を$P=0.002$（$P=0.05/25$）とした場合でも全項目が有意であった。

また，性・年齢とNo. 1～No. 25の全項目を同時に投入したモデルで，有意にオッズ比が上昇したものは「No. 2）日用品の買物をしていますか」，「No. 4）友人の家を訪ねていますか」，「No. 7）椅子に座った状態から何もつかまらずに立ち上がっていますか」，「No. 9）この1年間に転んだことがありますか」，「No. 12）BMI＜18.5」，「No. 17）昨年と比べて外出の回数が減っていますか」，「No. 18）周りの人から『いつも同じ事を聞く』などの物忘れがあると言われますか」，「No. 19）自分で電話番号を調べて，電話をかけることをしていますか」，「No. 20）今日が何月何日かわからない時がありますか」であった。Bonferroniの補正によって有意水準を$P=0.002$（$P=0.05/25$）とした場合では，「No. 2)日用品の買物をしていますか」，「No. 12）BMI＜18.5」，「No. 17)昨年と比べて外出の回数が減っていますか」，「19)自分で電話番号を調べて，電話をかけることをしていますか」が有意に関連した。

3.　基本チェックリストの各分野の該当基準における要介護認定発生のオッズ比

基本チェックリストの各分野の基準への該当状況と要介護認定の発生状況，および多重ロジスティック回帰分析による各分野の基準に該当した場合の要介護認定発生のオッズ比を示す（表2）。

「二次予防事業の対象者」の選定基準に該当した者は，5,560人（38.0%）であった。なお，「栄養改善」は各分野の中で特に該当した者の割合が低かった。

前項の各項目の結果と同様に，各分野の該当基準についても，「該当なし」の者に比べて「該当あり」の者で，新規認定者の割合が高かった。

性・年齢を補正したモデルによる解析の結果，全ての分野の基準で有意なオッズ比の上昇を認めた（オッズ比の範囲：1.93～6.54）。Bonferroniの補正によって有意水準を$P=0.006$（$P=0.05/8$）とした場合でも，全ての分野の基準で有意であった。なお，「二次予防事業の対象者」の基準に該当した場合のオッズ比（95%CI）は3.80（3.02-4.78）であった。

4.　基本チェックリストの各分野の該当基準における感度・特異度・陽性反応適中度

基本チェックリストの各分野の基準に該当した場合の，感度・特異度・陽性反応適中度を示す(表3)。

「二次予防事業の対象者」の感度・特異度は78.1%・63.4%であった。「二次予防事業の対象者」

表2　基本チェックリストの各分野の該当基準における要介護認定発生のオッズ比

該当基準	該当なし				該当あり				性・年齢補正[xi]	
	回答		うち要介護認定発生		回答		うち要介護認定発生			
	人数	%[i]	発生数	%[ii]	人数	%[i]	発生数	%[ii]	OR (95%CI)[xii]	*P*
うつ予防・支援の5項目を除く20項目[iii]	12,992	88.8	214	1.7	1,644	11.2	269	16.4	6.54 (5.31–8.04)	<.0001
運動器の機能向上[iv]	11,169	76.3	180	1.6	3,467	23.7	303	8.7	3.44 (2.80–4.22)	<.0001
栄養改善[v]	13,996	95.6	418	3.0	640	4.4	65	10.2	2.44 (1.83–3.26)	<.0001
口腔機能の向上[vi]	11,556	79.0	283	2.5	3,080	21.0	200	6.5	1.93 (1.59–2.34)	<.0001
閉じこもり予防・支援[vii]	12,303	84.1	291	2.4	2,333	15.9	192	8.2	2.20 (1.80–2.70)	<.0001
認知症予防・支援[viii]	8,855	60.5	138	1.6	5,781	39.5	345	6.0	2.81 (2.28–3.45)	<.0001
うつ予防・支援[ix]	10,077	68.9	168	1.7	4,559	31.2	315	6.9	2.94 (2.41–3.58)	<.0001
二次予防事業の対象者[x]	9,076	62.0	106	1.2	5,560	38.0	377	6.8	3.80 (3.02–4.78)	<.0001

i：全解析対象者（14,636名）に対する割合（%）
ii：回答人数に対する割合（%）
iii：No. 1 から No. 20の20項目のうち10項目以上で該当
iv：No. 6 から No. 10の5項目のうち3項目以上で該当
v：No. 11とNo. 12の2項目のうち2項目に該当
vi：No. 13から No. 15の3項目のうち2項目以上で該当
vii：No. 16から No. 17のうち No. 16に該当
viii：No. 18からNo. 20の3項目のうち1項目以上で該当
ix：No. 21からNo. 25の5項目のうち2項目以上で該当
x：上記のうち，うつ予防・支援の項目を除く20項目，運動器の機能向上，栄養改善，口腔機能の向上のいずれかの基準に該当する者
xi：性，年齢と上記の各項目（1項目ずつ）について投入したモデル（多重ロジスティック回帰分析。基準に該当しない場合が基準）。
xii：オッズ比（95%信頼区間）

表3　基本チェックリストの各分野の該当基準における，新規要介護認定発生に対する感度・特異度・陽性反応適中度（%）

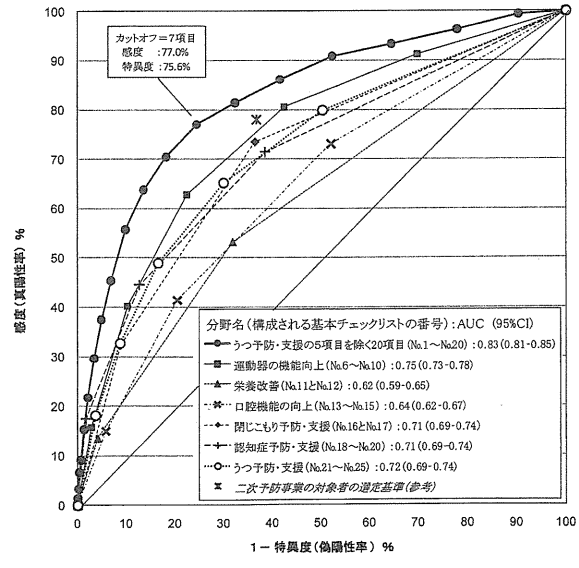
該当基準	感度	特異度	陽性反応適中度
うつ予防・支援の5項目を除く20項目[i]	55.7	90.3	16.4
運動器の機能向上[ii]	62.7	77.6	8.7
栄養改善[iii]	13.5	95.9	10.2
口腔機能の向上[iv]	41.4	79.7	6.5
閉じこもり予防・支援[v]	39.8	84.9	8.2
認知症予防・支援[vi]	71.4	61.6	6.0
うつ予防・支援[vii]	65.2	70.0	6.9
二次予防事業の対象者[viii]	78.1	63.4	6.8

i：No. 1 から No. 20の20項目のうち10項目以上で該当
ii：No. 6 から No. 10の5項目のうち3項目以上で該当
iii：No. 11と No. 12の2項目のうち2項目に該当
iv：No. 13から No. 15の3項目のうち2項目以上で該当
v：No. 16から No. 17のうち No. 16に該当
vi：No. 18からNo. 20の3項目のうち1項目以上で該当
vii：No. 21からNo. 25の5項目のうち2項目以上で該当
viii：上記のうち，うつ予防・支援の項目を除く20項目，運動器の機能向上，栄養改善，口腔機能の向上のいずれかの基準に該当する者

の基準以外の各分野の感度の範囲は「栄養改善」の13.5%から「認知症予防・支援」の71.4%，特異度の範囲は「認知症予防・支援」の61.6%から「栄養改善」の95.9%であった。

陽性反応適中度は，「二次予防事業の対象者」では6.8%，であった。「二次予防事業の対象者」の基準以外では，「認知症予防・支援」の6.0%から「うつ予防・支援の5項目を除く20項目」の16.4%の範囲であった。

図3　要介護認定発生に対する基本チェックリストの各分野のROC曲線と曲線下面積（Area under the curve; AUC）



5.　要介護認定発生に対する基本チェックリストの各分野のROC曲線とAUC

要介護認定発生に対する基本チェックリストの分野別の該当項目数のROC曲線とAUCを示す（図

3)。AUCが最も高かったのは「うつ予防・支援の5項目を除く20項目」であり，0.83であった。その他の各分野におけるAUCは，数値が高い順に「運動器の機能向上」で0.75，「うつ予防・支援」で0.72，「閉じこもり予防・支援」で0.71，「認知症予防・支援」で0.71，「口腔機能の向上」で0.64，「栄養改善」で0.62であった。

Ⅳ 考　　察

本研究の目的は，基本チェックリストの各項目や各基準が要介護認定の発生をどの程度予測し得るかを検証することである。そのため，宮城県大崎市の65歳以上の住民を1年間追跡し，ベースライン時の基本チェックリストの回答とそれに基づく各基準について，第一に要介護認定の新規発生に対する関連の有無と強さ，第二に二次予防事業の対象者のスクリーニングの精度を検討した。

性・年齢を補正した多重ロジスティック回帰分析の結果，基本チェックリストの25項目全て，二次予防事業の対象者選定の際に用いられている「うつ予防・支援の5項目を除く20項目」，「運動器の機能向上」，「栄養改善」，「口腔機能の向上」，「閉じこもり予防・支援」，「認知症予防・支援」，「うつ予防・支援」の7分野の基準と，包括的な基準である「二次予防事業の対象者の選定基準」に該当した場合の全てで，その後1年間の要介護認定発生のオッズ比が有意に上昇しており，要介護認定の新規発生に対する関連が強いことが示された。

スクリーニングの精度については，「二次予防事業の対象者の選定基準」の感度・特異度は78.1%・63.4%と比較的良好であったが，陽性反応適中度は6.8%と低かった。また，該当基準とされている各分野のうち，AUCが最も高かったのは「うつ予防・支援の5項目を除く20項目」であり，スクリーニングの精度が最も高いことが明らかとなった。

1. 集団の特性

年齢構成について全国値と比較する。本研究の解析対象者の年齢構成は，65-69歳26.9%，70-74歳30.0%，75-79歳25.2%，80-84歳12.5%，85歳以上5.4%であった。一方，調査基準日直近のデータである「平成18年10月1日現在推計人口」の全高齢者人口[10]から2006年12月審査分の「介護給付費実態調査月報（第4表）」による全国の要介護認定者数[11]を差し引き，全国の要介護認定を受けていない者と仮定すると，年齢構成は，65-69歳33.3%，70-74歳28.5%，75-79歳20.7%，80-84歳11.6%，85歳以上5.9%であった。本研究の解析対象者では，75歳以上の高齢者の割合がやや多いものの，大きな差異はみられず，全国の状況と大きく変わらない年齢構成と考えた。

資料　基本チェックリスト25項目の構成，分野ごとの該当基準，二次予防事業の対象者の選定基準の内容

基本チェックリスト25項目の構成
- No. 1～No. 5：IADL[i]（手段的日常生活動作）
- No. 6～No. 10：運動器の機能向上
- No. 11～No. 12：栄養改善
- No. 13～No. 15：口腔機能の向上
- No. 16～No. 17：閉じこもり予防・支援
- No. 18～No. 20：認知症予防・支援
- No. 21～No. 25：うつ予防・支援

分野ごとの該当基準（7分野）
- **二次予防事業の対象者の選定基準となる各分野の基準**
  - ①「うつ予防・支援の5項目を除く20項目」：No. 1～No. 20のうち10項目以上
  - ②「運動器の機能向上」：No. 6～No. 10のうち3項目以上
  - ③「栄養改善」：No. 11とNo. 12の2項目
  - ④「口腔機能の向上」：No. 13～No. 15のうち2項目以上
- **二次予防事業の対象者が併せて支援を考慮される各分野の基準**
  - ⑤「閉じこもり予防・支援」：No. 16とNo. 17のうちNo. 16
  - ⑥「認知症予防・支援」：No. 18～No. 20のうち1項目以上
  - ⑦「うつ予防・支援」：No. 21～No. 25のうち2項目以上

二次予防事業の対象者の選定基準
- ①～④のいずれかの分野の基準に該当

i：Instrumental Activity of Daily Living

次に二次予防事業の対象者に該当する割合について全国値と比較した。大崎市の高齢者人口31,694人のうち46.2%にあたる14,636人を解析対象とした本研究の二次予防事業の対象者に該当する割合は38.0%であった。一方，平成19年度の全国調査である「今後の介護予防事業のあり方に関する研究」では，高齢者人口の29.4%にあたる6,880,220人に基本チェックリストを実施し，そのうち特定高齢者候補者（現：二次予防事業の対象者）の該当率は19.8%であった[12]。以上より，本研究での割合が1.9倍高かった。しかし，「今後の介護予防事業のあり方に関する研究」では，基本チェックリスト実施者のうち，「基本健康診査（生活機能評価）を通じて把握」が89.5%であることから，健康診査を受けるほど意識の高い者を対象としていることや健康診査を受けることができるほど健康な者が対象となっているという選択バイアスの影響を受けている可能性が考えられる。一方，本研究は全市民を調査対象としていることから，より身体機能等が低く二次予防事業の対象者となるリスクの高い者も含んだ，選択バイアスの比較的少ないデータであると考えられる。

次に1年間での要支援・要介護と新規認定された者の割合について先行研究と比較する。川越は，解

析対象をベースライン時に基本チェックリストの全てに回答し，基本健康診査に2年連続で受診した者とし，65歳以上の松江市民の35.9％にあたる16,503人を解析したところ，新規認定者の割合は2.2％であったと報告している[4]。これと比較して，本研究は3.3％と高かった。高齢者における健康診査未受診者では，生活機能の低下者が多いことや，疾病，閉じこもり，喫煙習慣がある者，運動習慣の少ない者が多く，生命予後が悪いことが知られており[13,14]，川越の報告では基本健康診査に2年連続で受診した者について解析していることから，やはり選択バイアスがこの割合の差に関連していると考えられる。

以上のことから，本研究結果は，より地域在住高齢者の状況を反映したデータであることが示唆された。

2. 基本チェックリストの各項目・各分野における要介護認定発生のオッズ比

加齢によって要介護度が高くなるとともに基本チェックリストの該当項目数が多くなることは知られているが[8]，年齢を補正しても，要介護認定発生のリスク因子として基本チェックリストが関連の強いものであるか確認されていなかった。本研究の結果，性・年齢を補正してもなお，No. 1～No. 25の全項目で有意なオッズ比の上昇を認めていた。これによって，性・年齢を考慮しても，基本チェックリストの全項目が要介護認定の新規発生と強く関連することが，初めて確認された。

一方，これに関連する報告として，川越は，性，年齢，松江市版の基本チェックリストを同時に投入したモデルの多重ロジスティック回帰分析を行い，オッズ比の有意な上昇が7項目でみられたことを報告している[4]。松江市版の基本チェックリスト特有の5項目は含まないが，本研究結果でも同様に25項目の同時投入のモデルの結果を示しており，「No. 9) この1年間に転んだことがありますか」，「No. 17)昨年と比べて外出の回数が減っていますか」，「No. 18)周りの人から『いつも同じ事を聞く』などの物忘れがあると言われますか」，「No. 20)今日が何月何日かわからない時がありますか」については有意にオッズ比の上昇していることが共通していた。しかし，基本チェックリストの分野内には類似した質問項目が複数存在すること，本研究結果の「No. 16)週に1回以上は外出していますか」では性・年齢補正で有意なオッズ比の上昇であったのが同時投入ではオッズ比の減少に結果が逆転していたことから，多重共線性の影響が危惧される。このため，同時投入のモデルの結果を重視すべきではないと考えられる。

また，基本チェックリストの各分野の該当基準についても，性・年齢を補正してもなお，全ての分野の基準で新規要介護認定発生のオッズ比が有意に上昇しており，「二次予防事業の対象者」の基準に該当した場合のオッズ比（95％CI）は3.80（3.02-4.78）であった。このことから，現行の基本チェックリストによる全ての分野の基準，そして「二次予防事業の対象者の選定基準」が要介護認定の新規発生と強く関連することが確認された。なお，各分野の中で，特に要介護認定の発生のオッズ比が高いのは「うつ予防・支援の5項目を除く20項目」であった。この基準は，各項目でみた場合でオッズ比が高かった「2)日用品の買物をしていますか」や「4)友人の家を訪ねていますか」といったNo. 1～No. 5の「IADL（手段的日常生活動作）」の項目を唯一含んでいる基準である。「うつ予防・支援の5項目を除く20項目」の基準に該当する者のうち，「IADL」の項目を1項目以上含んでいた者は94.5％，4項目以上含んでいた者は48.1％と約半数であったことからも（図表データ掲載なし），「IADL」の項目を含んでいることが，オッズ比が高くなった一因と考えられる。

3. 各分野の感度・特異度・陽性反応適中度およびROC曲線・AUC

基本チェックリストは，要介護状態になるおそれの高い者のスクリーニングに用いられているため，スクリーニングツールとしての精度評価が必要である。そこで，本研究では，新規要介護認定の発生を外的基準として，各基準の感度・特異度・陽性反応適中度の算出およびROC分析を行った。同様の報告として，鈴木らは2年間の要介護認定の新規発生に対する「二次予防事業の対象者の選定基準」の感度・特異度を73.5％・57.8％と報告している[3]。一方，本研究における感度・特異度は78.1％・63.4％であり，ほぼ同等の感度・特異度が得られた。

次に現行の二次予防事業の対象者選定の際に用いられている各分野の基準についてであるが，これに関してはこれまでスクリーニングツールとしての精度評価は行われていなかった。本研究結果を分野別にみると，「うつ予防・支援の5項目を除く20項目」は，感度と特異度を合わせた値，陽性反応適中度，AUCの全てが最も高いことが明らかとなった。

なお，今回実施したROC分析では，Youden indexを用いて，AUC＝0.50となる斜線から最も離れたポイントを最適カットオフポイントとして求めることができる[15,16]。すなわち，「感度＋特異度－1」を計算し，その最大値となるポイントをカットオフ

ポイントにするという方法である。これに基づいた最適カットオフポイントと現行の基準が異なるのは，「うつ予防・支援の5項目を除く20項目」と「栄養改善」であり，Youden indexの最大値は「うつ予防・支援の5項目を除く20項目」では7項目以上，「栄養改善」では1項目以上を該当基準にした場合であった。このことから，「うつ予防・支援の5項目を除く20項目」と「栄養改善」では，カットオフポイントの変更によりスクリーニングの精度が改善する可能性があることが示唆された。

表3および図3の参考値のように「二次予防事業の対象者の選定基準」の感度・特異度は78.1%・63.4%であった。しかし，陽性反応適中度は6.8%と，その値は十分高いものとはいえず，偽陽性者が多く拾い上げられるため，二次予防事業の対象者把握事業の担当者に負担をもたらす結果となっている。一方，「うつ予防・支援の5項目を除く20項目」の最適カットオフポイントとして抽出された7項目以上を該当基準とした場合の感度・特異度は77.0%・75.6%と，同等の感度であるにも関わらず特異度が12.2ポイント高かった。特異度が高い分だけ偽陽性率も低いことを表すが，「うつ予防・支援の5項目を除く20項目」の7項目以上を基準に該当ありとした場合では陽性反応適中度も9.7%（図表データ掲載なし）と，「二次予防事業の対象者の選定基準」の6.8%に比べて1.4倍高かった。以上のことから，現行の基準の中でも，総合的な指標である「うつ予防・支援の5項目を除く20項目」の合計該当項目数を，より重視すべきだと考えられる。

その他の項目について，「栄養改善」，「口腔機能の向上」はAUCが比較的低くなっており，質問項目の内容を検討する余地があることも考えられる。また，現行の二次予防事業の対象者の選定基準に入っていないが，「うつ予防・支援」，「認知症予防・支援」，「閉じこもり予防・支援」のAUCについては，「運動器の機能向上」に比べて低いものの，「栄養改善」と「口腔機能の向上」に比べて高いことから，これらの分野の基準もスクリーニングに有用であると考えられる。

4. 本研究の限界

本研究の限界は，第一に質問紙が未回収だった者7,815人（対象の24.7%）に加え，要介護認定に関する情報提供の同意を得られなかった者が6,333人（対象の20.0%）おり，よりリスクの高い者が解析対象に含まれていない可能性があることである。実際に，有効回答者と非有効回答者を比較した結果，平均年齢は非有効回答者の方が高かった。さらに，要介護認定に関する情報提供の同意者と非同意者を比較した結果でも，平均年齢はほぼ等しいものの，基本チェックリスト25項目での該当項目数の平均値は，非同意者の方が高かった。すなわち，本研究でも，より生活機能が悪い者の調査参加率が低くなり，それによって要支援・要介護と新規認定された者の割合が低くなっていることは否定できない。このことから，二次予防事業の対象者の基準に該当する者や要介護新規認定者の割合が過小評価されたことが考えられる。また，要介護新規認定者の割合が低くなることによって基本チェックリストの陽性反応適中度が過小評価されたことが考えられる。しかしながら，前述したように，健康診査の受診者を対象とした研究[4]と比較して，選択バイアスが比較的少なく，より地域在住高齢者の状況を反映したデータであると考える。

第二に要介護認定を受けた原因や詳細な生活機能の程度が不明な点である。したがって，本研究ではどのような要因によって，生活機能がどの程度低くなったことにより要介護認定に至ったのか把握することができない。

V 結　　語

本研究により，基本チェックリストの各項目や，現行の二次予防事業の対象者選定の際に用いられる各基準が，1年間での要介護認定の新規発生と強く関連することが明らかとなった。スクリーニングの精度については，「二次予防事業の対象者の選定基準」の感度・特異度は78.1%・63.4%と比較的良好であった。該当基準とされている各分野のうち，ROC曲線下面積が最も高かったのは「うつ予防・支援の5項目を除く20項目」であり，7項目以上を該当基準とした場合，「二次予防事業の対象者」の基準に比べ，感度は変わらないが（77.0% vs. 78.1%），特異度は高かった（75.6% vs. 63.4%）。

以上のことから，基本チェックリストの各項目や現行の二次予防事業の対象者選定の際に用いられている該当基準は，その後1年間の要介護認定の新規発生の予測に有用であることが示唆された。しかし，項目や分野によって関連の強さや予測精度は異なり，基準値には改善の余地があった。

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Validation of the Kihon Checklist for predicting the risk of 1-year incident long-term care insurance certification: The Ohsaki Cohort 2006 Study

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Key words : the Kihon Checklist, prevention of the need for care, long-term care insurance certification, predictive validity, frail elderly

Objective The "Kihon Checklist" (a frailty checklist), consisting of 25 items, is used for screening frail elderly, based on the Japanese long-term care insurance system. However, few reports have investigated predictive ability of incident long-term care insurance certification in the Kihon Checklist. The purpose of this study was to investigate inter-relationships and accuracy as a screening test of individual items and criteria in the Kihon Checklist for incident long-term care insurance certification.

Methods In December 2006, we distributed a questionnaire including the Kihon Checklist to individuals older than 65 years living in Ohsaki City, Japan. Among the valid respondents, we followed those who gave informed consent to follow-up, had more than 1 item of response on the Kihon Checklist, and were not qualified for long-term care insurance certification at the baseline. We further excluded individuals who died or moved away in the one year follow-up, analyzing 14,636 elderly. The age- and sex-adjusted odds ratio (OR) and 95% confidence interval (95%CI) for newly incident long-term care insurance certification were estimated by logistic regression analysis. Independent variables were each of the items and criteria in the Kihon Checklist used for screening of "frail elderly". In addition, we estimated the sensitivity and specificity, and conducted receiver operating characteristic (ROC) analysis for each criteria domain.

Results 5,560 (38.0%) matched the criteria of "frail elderly". During the one year of follow-up, 483 (3.3%) required newly incident long-term care insurance certification. All of the items in the Kihon Checklist were significantly associated with incident long-term care insurance certification (range of ORs: 1.45–4.67). In addition, all of the criteria also significantly predicted the risk of incident long-term care insurance certification (range of OR: 1.93–6.54). The OR (95%CI) for "frail elderly" was 3.80 (3.02–4.78). Among the various domains, "20 items other than five related to prevention and support for depression" had the largest area under the ROC curve.

Conclusion All items and criteria used for screening frail elderly in the Kihon Checklist are useful for predicting the risk of incident long-term care insurance certification during a one-year period. However, the strength of the relation and accuracy for screening test were variable among items or domains, and criteria values could be improved.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Impact of physical activity and performance on medical care costs among the Japanese elderly

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Aim: Physical activity (PA) is known to be inversely associated with medical care costs. The amount of PA is strongly associated with the level of physical performance among the elderly population. Therefore, it is possible that known relation between PA and medical care merely shows the relation between physical performance and medical care. To know whether PA itself relates to medical care, considering physical performance is necessary. The aim of this study was to ascertain the impact of PA on medical care expenditure by considering the physical performance in an elderly community-dwelling population.

Methods: We investigated 483 subjects who did not have any history of diseases relating to limited PA and who completed both a self-administered questionnaire including questions on PA and underwent a physical performance measurement. We ascertained the total medical care costs through a computerized linkage with claims lodged between August 2002 and March 2008 with the Miyagi National Health Insurance Association.

Results: The physical performance was positively associated with their level of PA. After multivariate adjustment for covariables including the levels of physical performance, the per capita medical care costs were found to be $US 827.3 (598.0–1056.7) (mean, 95% confidence interval), $US 711.1 (476.4–945.8) and $US 702.0 (461.6–942.4) (*P* for linear trend = 0.02) per month for those who had the lowest, average and the highest level of PA, respectively.

Conclusion: This prospective study indicates that a higher level of PA is associated with lower medical care costs among the Japanese elderly irrespective of physical performance. **Geriatr Gerontol Int 2011; 11: 157–165.**

Keywords: community-dwelling elderly population, medical care costs, physical activity, physical performance.

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Introduction

The rising medical care costs associated with the growth of the elderly population is an ongoing problem worldwide.[1,2] In the 2005 Japanese census report, the proportion of the elderly population in the total population of the country was 20.1%. This proportion is expected to

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reach 35.7% by 2050.[3] In the 2002 Health and Welfare Statistics Association survey, 50.4% of the total national medical care costs were incurred by elderly individuals over 65 years of age.[4] According to the survey, the average per capita monthly medical care costs were $US 1284 for the under-65 age group and $US 5536 for the over-65 age group; that is, the costs for the latter group were five times higher than those for the former.

A sedentary lifestyle has been found to be associated with an increased risk of developing various chronic diseases and mortality.[5–8] Actually, several studies have reported that physical activity (PA) is inversely associated with medical care costs.[9–11] The promotion of regular PA may lead to a reduction in medical care costs. The amount of PA, however, is strongly associated with the level of physical performance, especially in the elderly population.[12–17] Therefore, it is natural to assume that physical performance would be an important mediator in the relationship between PA and medical care costs. Thus, careful consideration of this potentially important confounding or effect-modifying factor is needed when analyzing the data. However, to our knowledge, no previous studies have investigated the impact of physical activity on medical care expenditure using stratified analyses of physical performance levels.

We thus designed a cohort study of National Health Insurance (NHI) beneficiaries to investigate the link between PA levels and medical care costs in association with physical performance in an elderly Japanese community-dwelling population.

Methods

Study participants

Our data were derived from a prospective observation of NHI beneficiaries in suburban Japan through August 2002 to March 2008. In 2002, there were 2730 individuals aged 70 years and older living in Tsurugaya, a residential area in one of the major cities in northern Japan, Sendai City. We invited all of these individuals to participate in a comprehensive geriatric assessment[18] in which the physical, mental and social functioning of elderly people was examined to assess the early deterioration that could result in the need for long-term care and thus to promote healthy aging. Of those invited, 1178 gave written informed consent to being included in the structured survey. Of these 1178, we investigated 969 persons who agreed to respond to a questionnaire on medical care costs, the coverage of these costs under the NHI system, and medical care utilization derived from claim history files. The comprehensive health and lifestyle information for each subject at baseline allowed us to adjust for a variety of potential confounders. The protocol of this study was approved by the Institutional Review Board of the Tohoku University Graduate School of Medicine.

We excluded the subjects who provided incomplete data in the PA questionnaire ($n = 130$), or who had not been tested for physical performance ($n = 70$). Furthermore, we excluded all potential subjects with notable comorbidities that could influence the frequency and degree of PA, that is, those who reported being incapable of walking 50 m independently ($n = 58$) and those with a history of arthritis ($n = 107$). Of the remaining 604 subjects, we further excluded those who reported a history of stroke ($n = 26$), coronary heart disease ($n = 61$), cancer ($n = 33$), and the one subject reporting cognitive dysfunction (Mini-Mental State Examination [MMSE] score <18) in the baseline survey. As a result of these exclusions, the final study population comprised 483 (231 male and 252 female) subjects. The mean age was 75.5 years (standard deviation [SD] = 4.2).

Data on medical care costs

We prospectively collected data on medical care use and costs for all individuals in the cohort study that extended from August 2002 to March 2008. We obtained the NHI claims history files from the Miyagi NHI Association. These files included the total number of outpatient visits, the total number of days of inpatient care, and the charges for outpatient and inpatient care, respectively.

When a beneficiary was withdrawn from the NHI, the date and reason were coded on an NHI withdrawal history file. This file identified the survival and emigration status for each subject. Both the NHI claims and withdrawal history files were linked with our baseline survey data file, with the beneficiary's ID number functioning as the key code. Monthly medical expenditures for each subject were calculated by dividing the total medical expenditures throughout the observation period by the number of months observed. We used monthly values rather than cumulative values to avoid underestimating medical expenditures for subjects who died or emigrated during the follow up.

Assessment of PA

A self-reported single-item questionnaire was used to estimate the different levels of PA in each subject. The subject was asked whether he or she had performed any activities from the following categories in the previous 12 months: walking, brisk walking, or sports (e.g. aerobics, tennis, swimming, jogging, etc.). If they had participated in a given activity, the frequency of and duration of time spent in performing the activity were ascertained using the following categories: for frequency

Table 1 Definition of physical activity level (n = 483)

	Low		Moderate		High	
No. of participants	115	90	114	46	66	52
Walking	None	Low	High	Any	Any	Any
Brisk walking	None	None	None	Low	High	Any
Sports	None	None	None	None	None	Low and high
Walking						
None	115	0	0	14	41	22
Low	0	90	0	15	1	14
High	0	0	114	17	24	16
Brisk walking						
None	115	90	114	0	0	32
Low	0	0	0	46	0	7
High	0	0	0	0	66	13
Sports						
None	115	90	114	46	66	0
Low	0	0	0	0	0	48
High	0	0	0	0	0	4

High, at least 3–4 times/week for at least 30 min each time; low, reporting some activity in the past year, but not enough to meet high levels; none, no physical activity.

(i) 1–2 times/month; (ii) 1–2 times/week; (iii) 3–4 times/week; or (iv) almost every day; and for duration (per walk or workout) (i) 0–30 min (<30 min); (ii) 0.5–1 h (≥0.5 h, <1 h); (iii) 1–2 h (≥1 h, <2 h); (iv) 2–3 h (≥2 h, <3 h); (v) 3–4 h (≥3 h, <4 h); or (vi) 4 h or more (≥4 h). Among the levels of exercise intensity, sports were considered the highest, followed in order by brisk walking and walking. Each of the three types was further classified into three subcategories according to the frequency and duration of the walks or workouts as follows:[19,20] (i) high, at least 3–4 times/week for at least 30 min each time; (ii) low, some activity in the past year, but not enough to meet the criteria for the high group; and (iii) none, no PA. Finally, we used these categories and subcategories to define the following three levels of PA (Table 1): (i) low, no sports, no brisk walking, low amount of walking; (ii) moderate, no sports, low amount of brisk walking, any amount of walking; and (iii) high, any amount of sports, any amount of brisk walking, any amount of walking. Table 1 also shows the number of participants according to the PA levels.

Assessment of physical performance measurement

Leg muscle power (w/kg)

Bilateral leg muscle power was measured on a horizontal leg extension apparatus (Combi Anaeropress 3500, Tokyo, Japan). Participants were positioned well back on a seat, supported at the waist by a belt, and their feet were placed on a sliding board with the knee joints angled at 90°. The resistance of the sliding board was adjusted according to the bodyweight. Participants were asked to extend their knees to push away the sliding board as hard as they could. The leg extension power was then measured. The trials were separated by 15-s rest intervals. The average of the two highest leg power measurements among five trials conducted was recorded as the "leg muscle power" and the resulting power was divided by the bodyweight.

Functional reach (cm)

Participants were asked to reach as far forward as possible while maintaining a fixed base of support, with their feet placed comfortably apart (approximately shoulder-width) but in symmetrical sagittal alignment. The distance reached was measured (in cm) on a tape measure fixed to the wall. This test was repeated three times and the longest distance measured was recorded.[21]

Timed "Up & Go" test (s)

Participants were seated in a free-standing padded armchair (46 cm high) and asked to rise (with or without using the armrests), walk to a mark 3 m away, turn around, walk back to the chair and sit down. The time between consecutive risings from the seat and contact made with the back of the seat was measured (s). This test was repeated three times and the fastest walk was recorded.[22]

10-m maximum walk test (m/s)

Each participant was asked to walk 10 m at his or her maximum walking speed. A stopwatch was used for timing the walk, and a counter was used to ascertain the number of steps. To eliminate the periods of acceleration and deceleration, subjects started their laps 3 m before the beginning of the walkway and concluded them 3 m beyond its end. The test was repeated three times, and the data of the fastest walk were recorded. These data were used to determine each subject's maximum walking speed (m/s).[23]

As regards the assessment of physical performance, the results of the four tests described above were each stratified into tertiles. We assigned, for each category of physical performance tests, a score of 3 for those in the highest tertile, 2 for those in the moderate and 1 for those in the lowest tertile. These scores were then added, so that they ranged 4–12. Those with scores in the ranges of 4–6, 7–9 or 10–12 were categorized as having a low, moderate or high level of physical performance, respectively.

Assessment of other variables

Anthropometric measures (e.g. height, bodyweight) were recorded by a standardized protocol. Blood pressure (BP) was measured at home with an HEM747IC device (Omron Life Science, Tokyo, Japan) that uses the cuff-oscillometric method to generate a digital display of systolic and diastolic pressures. The mean of 15.6 ± 10.5 (SD) BP measurements was used as the BP value. Participants who did not measure their home BP on at least 3 days were treated as having missing information on hypertension.

Blood samples were drawn from the antecubital vein of the seated subject with minimal tourniquet use. Specimens were collected in siliconized vacuum glass tubes containing sodium fluoride for blood glucose and no additives for lipid analyses.

The total cholesterol (T-C) and blood glucose levels of the subjects were measured by enzymatic methods (T-C, Denka Seiken, Tokyo, Japan; blood glucose, Shino-Test, Tokyo, Japan). Data on smoking status, alcohol consumption and history of liver or renal disease were obtained from the questionnaire survey. A well-trained pharmacist confirmed the drug information.

History of physical illness was evaluated on the basis of the responses ("yes" or "no") to questions concerning the history of liver and renal disease. Depressive symptoms were assessed according to the Japanese version of the 30-item Geriatric Depression Scale (GDS).[24] The participants were further tested for cognitive ability based on the MMSE.[25] Information on smoking (never, former and current smoking) and drinking (never, former and current drinking) status of the participants was obtained from a questionnaire survey.

Definitions of variables

Hypertension was defined as a home systolic BP reading of 135 mmHg or above and/or a home diastolic BP reading of 85 mmHg or above or use of antihypertensive agents.[26] Diabetes was defined as a casual blood glucose concentration of 200 mg/dL or above or the current use of antidiabetic medication. Hyperlipidemia was defined as a T-C level of 220 mg/dL or above, or the current use of a lipid-lowering agent. A GDS score of 14 or more or the use of an antidepressant was taken to indicate depressive symptoms.[27] An MMSE score of less than 24 was taken to indicate cognitive impairment.[28]

Medical care use and its costs were indicated by the number of hospital days, number of physician visits and medical care costs (total, inpatient and outpatient). Inpatient medical care costs included the cost of almost all the medical treatment received at hospitals, such as that incurred in diagnostic tests, medication, surgery, supplies and materials, paying the physician's fees and other personnel costs, but did not include hospital meal fees. Outpatient medical care costs included the money spent in medical treatment at outpatient clinics, prescribed drugs and home care services provided by physicians, but did not include dental care.

The number of hospital days, the number of physician visits and the medical care costs were calculated as per capita per month indices, including all subjects and months of observation irrespective of whether or not the former had received care.

Statistical analysis

Descriptive data are presented as means (95% confidence interval [CI]) or percentages. The variables' differences according to the levels of PA were examined by the ANCOVA for continuous variables or by the multiple logistic regression analysis for variables of proportion. The impact of PA or physical performance on the medical costs and number of outpatient visits and hospital days, respectively, were examined using ANCOVA after adjustment for age, sex, body mass index (BMI), hypertension, hyperlipidemia, diabetes mellitus, history of liver or renal disease, depressive symptoms, cognitive status, smoking and drinking habits/history, and physical performance score. All *P*-values for linear trends were calculated by using the applicable category of the PA levels (low, 1; moderate, 2; high, 3). The interactions between the PA and covariables were assessed by testing the interaction term added to the adjusted model as a covariate. The impact of PA on medical costs and the number of outpatient visits and hospital days was

Table 2 Baseline characteristics of subjects by levels of physical activity ($n = 483$)

	Physical activity levels			*P* for trend
	Low	Moderate	High	
No. of participants	205	160	118	–
Age (years)	76.0 (75.4–76.6)	75.6 (74.9–76.2)	74.4 (73.6–75.1)	<0.001
Sex (female)	61.0	48.1	42.4	<0.001
BMI (kg/m^2)	23.8 (23.3–24.2)	23.4 (22.9–23.9)	23.4 (22.8–23.9)	0.26
Hypertension	70.2	67.5	60.2	0.07
Hyperlipidemia	45.4	44.4	39.0	0.29
Diabetes	7.3	9.4	8.5	0.65
Impaired cognitive function (18 ≤ MMSE < 24)	8.8	6.9	8.5	0.84
Depressive symptoms (GDS ≥14 or use of antidepressant)	20.0	16.9	9.3	0.02
Smoking status				
Current smoker	17.1	12.5	11.9	0.16
Ex-smoker	23.4	38.5	39.0	<0.01
Non-smoker	56.7	47.5	49.2	0.14
Drinking status				
Current drinker	40.0	41.9	50.9	0.07
Ex-drinker	11.2	12.5	15.3	0.30
Non-drinker	44.4	39.4	31.4	0.02
Self-reported illness				
Renal	6.8	5.0	3.4	0.18
Liver	6.3	6.9	5.1	0.71
Physical performance				
Knee extension power (w/kg)	9.3 (8.8–9.9)	11.3 (10.7–11.9)	13.1 (12.3–13.8)	<0.0001
Functional reach (cm)	30.2 (29.5–31)	31.3 (30.4–32.1)	32.1 (31.1–33.2)	<0.01
Timed "Up & Go" test (s)	9.3 (9.1–9.5)	8.9 (8.7–9.1)	8.3 (8.1–8.6)	<0.0001
10-m maximum walking (m/s)	1.7 (1.6–1.7)	1.8 (1.7–1.8)	1.9 (1.9–2.0)	<0.0001
Log-transformed total physical performance score	1.9 (1.9–2.0)	2.0 (2.0–2.1)	2.2 (2.1–2.2)	<0.0001

Variables are presented as least squares mean (95% confidence interval) or %. BMI, body mass index; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination.

examined in association with physical performance levels after adjustment for the above mediator.

In this paper, monetary values were converted into $US using the exchange rate of $US 1.00 = 115 ¥. $P < 0.05$ was regarded as statistically significant. SAS software ver. 9.1 was used for all statistical calculations.

Results

Descriptive

Of the 483 subjects, 205 (42.4%) were categorized at the lowest level of PA, 160 (33.1%) at the moderate level and 118 (24.4%) at the highest level. Table 2 shows the baseline characteristics of subjects categorized by the PA level. The mean age was significantly lower at the highest PA level (*P* for trend <0.001). Although not statistically significant, the BMI was highest at the lowest PA level (*P* for trend = 0.26). Physical performance (including the results of the four tests and the total physical performance score) and PA were found to be positively associated (*P* for trend <0.01). Generally, participants with a higher PA had a better physical performance score. The proportion of subjects who were female, had depressive symptoms and were non-drinkers was significantly lower in the higher PA levels (*P* for trend <0.001, =0.02 and 0.02, respectively). Although the difference was not statistically significant (*P* for trend = 0.07), the proportion of subjects with hypertension was lowest at the highest PA level. In contrast, the proportion of ex-smokers was significantly higher at the higher PA levels (*P* for trend <0.01). Other than the above-mentioned, no significant difference was observed among the PA levels.

Table 3 Association between total medical care costs and physical performance levels ($n = 483$)

Physical performance	Physical performance levels			*P* for trend†
	Low	Moderate	High	
Leg muscle power (w/kg)	0.8–8.7	8.8–12.6	12.7–23.4	–
No. of participants	160	162	161	–
Total medical costs, $US	892.4 (652.7–1132.2)‡	858.0 (631.2–1084.9)	718.2 (481.5–954.8)	0.01
Functional reach (cm)	6.3–29.1	29.2–33.5	33.6–45.6	–
No. of participants	159	161	163	–
Total medical costs, $US	847.5 (616.5–1078.4)	816.5 (583.6–1049.5)	806.1 (568.9–1043.2)	0.46
Timed "Up & Go" test (s)	16.8–9.4	9.4–8.1	8.1–5.6	–
No. of participants	161	162	160	–
Total medical costs, $	857.6 (626.9–1088.3)	819.8 (583.6–1056.0)	794.8 (561.4–1028.2)	0.25
10-m maximum walking (m/s)	0.9–1.6	1.7–1.9	1.9–3.1	–
No. of participants	160	162	161	–
Total medical costs, $US	898.6 (664.1–1133.0)	801.2 (572.1–1030.3)	795.5 (559.6–1031.5)	0.08
Total physical performance score	4–6	7–9	10–12	–
No. of participants	138	192	153	–
Total medical costs, $US	898.0 (662.0–1134.1)	823.4 (595.7–1051.1)	724.1 (485.1–963.2)	0.01

†Adjusted for age, sex, body mass index, hypertension, hyperlipidemia, diabetes, history of liver disease or renal disease, depressive symptoms, impaired cognitive function, smoking status, drinking status; ‡Variables are presented as least-squares mean (95% confidence interval) (all such values).

Association between physical performance and PA or medical care costs per person

Table 3 shows the relationship between medical care costs and physical performance measurements. Levels of physical performance tests were stratified into tertiles. Although medical care costs tended to be higher in the poorer physical performance tertiles, the leg muscle power and total physical performance score were found to be the only statistically significant measures (*P* for trend = 0.01) among the four tests administered after adjustment for covariables. Although not statistically significant, the medical care costs were lowest in the highest 10-m maximum walking group (*P* for trend = 0.08).

Association between PA levels and medical care costs per person

Table 4 shows the adjusted association between the PA level and the medical care costs and the average number of days of hospital stay or visits. After adjustment for covariables, the significant inverse relation of PA levels with inpatient cost, average number of days of hospital stay and total cost was observed (*P* for trend = 0.02, 0.046, and 0.02, respectively). No significant interaction was observed between the physical performance score and PA levels for inpatient, outpatient or total medical care costs (data not shown). In contrast, no relation was found between the levels of PA and outpatient expenditures or average number of hospital visits in all models. Similar results were also observed when men and women were analyzed separately. No significant interaction was observed between the physical performance score and the sex of the patient regarding inpatient, outpatient or total medical care costs. Stratified association between the PA levels and the total medical care costs (least-squares mean, 95% CI) by physical performance levels after adjustment for variables in the full multivariate model in Table 4 are shown in Figure 1. Except for a small sample ($n = 14$) group characterized by high PA with lower physical performance, the PA was inversely associated with medical cost in all the physical performance categories.

Discussion

The main finding of this study was that higher PA levels were associated with lower medical care costs and hospitalization days among Japanese community-dwelling elderly individuals. Higher physical performance levels were also associated with lower medical care costs. However, the inverse association between PA and medical care costs persisted even after adjustment for the level of physical performance (*P* for interaction = 0.48). These results suggested that the beneficial effect of PA on medical cost might be consistently observed irrespective of their baseline physical performance.

The strength of our study lies in the fact that we have measured both the PA and the physical performance. The unique characteristics of the study enabled us to clarify whether the PA itself predicts the medical cost or whether it merely marks the physical performance.

Table 4 Association between physical activity levels and medical care costs ($n = 483$)

	Physical activity levels			*P* for trend
	Low	Moderate	High	
No. of participants	205	160	118	–
Inpatient data, $US				
Model 1†	421.8 (227.4–616.1)‡	323.7 (123.4–524.0)	297.3 (90.0–504.5)	<0.01
Model 2§	389.3 (190.8–587.8)	296.7 (93.7–499.8)	282.3 (74.3–490.4)	0.02
No. of hospital days†				
Model 1†	1.9 (1.1–2.7)	1.5 (0.7–2.3)	1.4 (0.6–2.3)	0.02
Model 2§	1.7 (0.9–2.6)	1.4 (0.5–2.2)	1.4 (0.5–2.2)	0.046
Outpatient data, $US				
Model 1†	453.4 (346.6–560.3)	427.7 (317.6–537.9)	426.1 (312.2–540.1)	0.28
Model 2§	438.0 (328.9–547.2)	414.4 (302.7–526.0)	419.7 (305.3–534.0)	0.48
No. of physician visits†				
Model 1†	6.5 (4.6–8.4)	6.6 (4.6–8.5)	6.6 (4.5–8.6)	0.87
Model 2§	6.4 (4.4–8.3)	6.5 (4.4–8.5)	6.5 (4.4–8.6)	0.76
Total costs, $US				
Model 1†	875.2 (650.2–1100.2)	751.4 (519.5–983.4)	723.4 (483.4–963.4)	<0.01
Model 2§	827.3 (598.0–1056.7)	711.1 (476.4–945.8)	702.0 (461.6–942.4)	0.02

†Adjusted for age, sex, body mass index, hypertension, hyperlipidemia, diabetes, history of liver disease or renal disease, depressive symptoms, impaired cognitive function, smoking status, drinking status. ‡Variables are presented as least-squares mean (95% confidence interval) (all such values). §Adjusted for model 1 + total physical performance score.

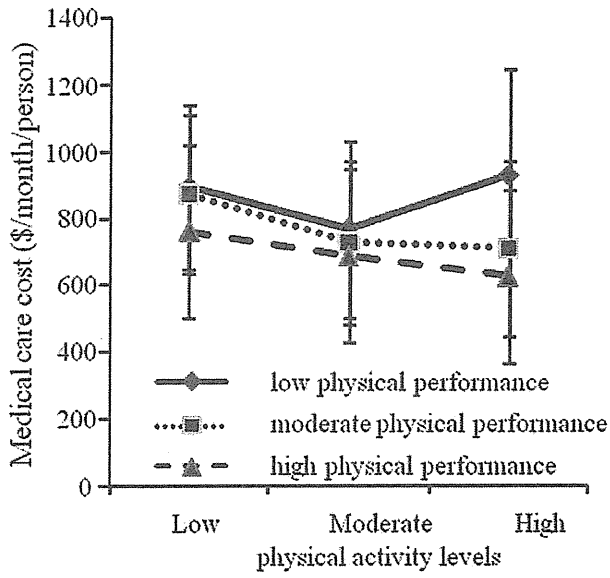

Figure 1 Association between physical activity levels and total medical care costs stratified by physical performance levels. Results from an analysis of covariance model adjusting for age, sex, body mass index, hypertension, hyperlipidemia, diabetes mellitus, history of liver disease or renal disease, depressive symptoms, impaired cognitive function, smoking status and drinking status. Variables indicate the adjusted least-squares mean. Error bars indicate 95% confidence intervals. Currency $US.

Individual reasons for medical treatment were not identified, but the fact that inpatient but not outpatient costs were higher among the community-dwelling subjects with lower levels of PA implies that these subjects may have suffered acute medical conditions requiring inpatient treatment. The outpatient care costs did not differ among the groups. The outpatient care costs were not influenced by the level of PA, partly because the proportion of elderly patients receiving medication for chronic diseases that did not affect their daily PA (e.g. hyperlipidemia or hypertension) did not differ among the groups, and such medication was mostly prescribed regularly for a long period of time. It should be noted that only one-fifth of the subjects in each group were not medicated.

As we have previously reported, it was found in a population study involving 27 431 Japanese men and women aged 40–79 years that those who walked for more than 1 h per day paid less for medical care.[10] We reported that both inpatient and outpatient costs taken cumulatively were smaller among the active walkers, which seems to conflict with our present result. This is probably because in the earlier study the population was younger and more than 70% of the participants reported that their health was good or excellent. Another factor responsible for the conflict in results might be the difference in the methods employed for estimating PA. Therefore, it is most likely that the majority of the previous study population was non-medicated and did not suffer from

chronic diseases, which stands in remarkable contrast with the present study population. Wang *et al.* also reported in their cross-sectional study that the frequency of PA had a strong dose–response effect on health-care costs in those above the age of 65 years.[9] A 10-year follow up of the participants in a randomized clinical trial of walking in the USA revealed that the subjects in the walking group continued to walk longer and had lower hospitalization rates than those in the control group.[29] However, the physical performance of the participants was not evaluated in any of the previous studies.

By excluding the subjects with a history of stroke, cancer or coronary heart disease who potentially incur greater medical care costs than those without a similar history, the study population's selection bias was sufficiently minimized. The fact that the accumulated medical care cost during the initial 6 months did not differ among the groups shows that leading bias was minimized.

A stratified analysis by physical performance levels showed that the inverse dose–response relationship between total medical care costs and PA was observed in the moderate and high physical performance levels (Fig. 1). In the low physical performance level, the total medical care costs were highest at the highest PA level. Although we cannot validly explain this result, the number of subjects in the highest PA level was very small ($n = 14$), and therefore the mean medical care cost for that level would be imprecise.

This study has several limitations. First, because all the assessment were carried out in a public facility, the participants were sufficiently active and healthy to participate in the survey; therefore, it is possible that the current results would not be applicable to subjects at a higher risk. Moreover, because arthritis and remarkably low physical function might influence the frequency and degree of PA, and many diseases such as stroke, coronary heart disease and cancer can be a reason for large medical care cost at baseline, we also excluded these participants. Therefore, our results may not represent the general elderly population. However, we believe that these exclusions were necessary to investigate the relation of PA with medical care cost. Second, the diagnosis for each instance of medical care use was not available. This prevented an examination of the effects of exercise on particular diseases. Third, the intensity of walking, brisk walking and sports were not directly measured. Therefore, the proportional amount of PA in terms of the energy expenditure required for reducing medical care costs cannot be determined. However, because a person can easily discriminate his or her own "brisk walking" from ordinary walking,[30] it was suggested that the categorization of relative walking intensity based on the subjects' own perceptions was reliable.

In conclusion, this prospective study indicates that a higher level of PA was associated with lower medical care costs irrespective of physical performance among the elderly Japanese.

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Original Article: Clinical Investigation

Risk factors for overactive bladder in the elderly population: A community-based study with face-to-face interview

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Objectives: The aim of this study was to measure the prevalence of and risk factors for overactive bladder (OAB) in the elderly.

Methods: A cross-sectional study of elderly subjects was conducted by analyzing data from a community-based Comprehensive Geriatric Assessment on people aged 70 years or older. Trained interviewers performed face-to-face interviews for the assessment of urological symptoms. OAB definition was based on urgency and eight or more episodes of urination per day. The subjects completed a self-administered questionnaire including lifestyle evaluation, Geriatric Depression Scale, Mini-Mental Status Examination and medical history. Brachial-ankle pulse wave velocity was recorded to assess atherosclerotic disease. The analysis included 833 subjects, after the exclusion of 115 subjects who provided insufficient information.

Results: Based on the definition of OAB, 153 subjects (18.4%) were identified as having OAB. Univariate analysis showed a significant association between OAB and depressive symptoms. Multivariate analysis showed that the risk of having OAB was significantly higher in subjects with depressive symptoms, current drinkers, and overweight subjects with odds ratios of 2.37 (1.60–3.52, 95% confidence interval), 1.65 (1.04–2.62), and 1.51 (1.02–2.24), respectively.

Conclusions: This is the first report to show an association between OAB and depressive symptoms and alcohol intake in an epidemiological study of elderly people. The reasons for these correlations remain unclear, but should be the foci of future OAB studies.

Key words: depression, elderly, face-to-face interview, overactive bladder, risk factors.

Introduction

In 2002, overactive bladder (OAB) was defined by the International Continence Society (ICS) as the symptom of urgency, which is an indispensable condition, with or without urge incontinence, usually with increased frequency and nocturia.[1] Many epidemiological and clinical studies of these symptoms have been reported.[2–5] OAB occurs in a wide range of patients from the comparatively young to the elderly. By contrast, the number of OAB patients increases in proportion to the subjects' age. The reason for this association is not clear. Thus, it might be possible to elucidate the origin of OAB by investigating the risk factors for OAB in elderly people through epidemiological studies.

We conducted a cross-sectional study on subjects aged 70 years or older in an urban community to measure the prevalence of overactive bladder (OAB) in the elderly, and assessed the risk factors of the condition.

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Methods

Study participants

In July and August 2003, a community-based comprehensive geriatric assessment in elderly people was performed in the Tsurugaya district of Sendai City, one of the largest cities in northern Japan.[6–10] At this time, 2925 people aged ≥70 years lived in Tsurugaya. We invited all of them to participate in the assessment of their medical status, physical function, cognitive function and dental status. Of those invited, 948 (32.4%) of them particiapated, after providing informed consent for analysis of the data. All assessments were carried out in a non-clinical public facility. The protocol of this study was approved by the institutional review board of the Tohoku University Graduate School of Medicine.

We excluded subjects who did not respond to the questions related to our analysis ($n = 107$). We further excluded

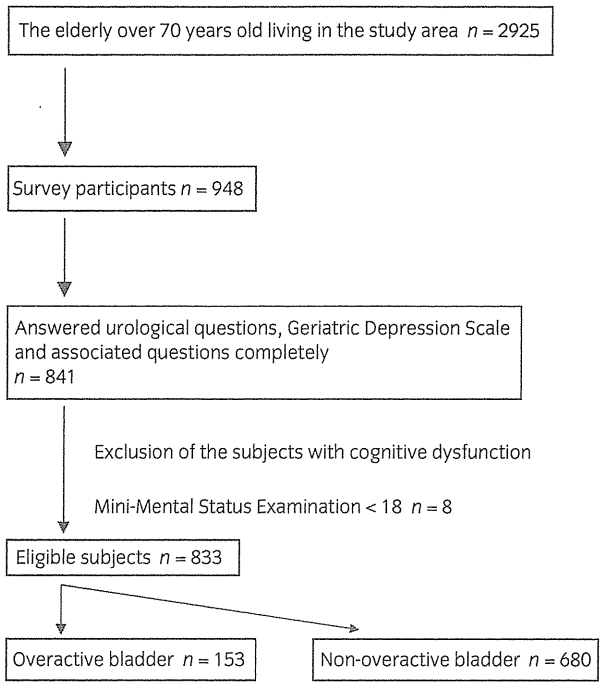

Fig. 1 The study flow.

participants who had scores of less than 18 points in the Mini-Mental Status Examination (MMSE), based on the possibility of incorrect answers due to dysgnosia ($n = 8$).[11] Therefore, a total of 833 subjects were included in the final analysis (Fig. 1).

Urological measurement

In the current study, we performed a survey of the symptoms of the lower urinary tract, including determination of the frequency of urination per day and the International Prostate Symptom Score (IPSS).[10,12] All urological interviews were performed by interviewers who were trained to identify that the urgency is the complaint of a sudden compelling desire to pass urine. OAB has been defined as urgency with urination eight times or more per day. Based on the survey results, the subjects were divided into OAB and non-OAB groups.

Anthropometric measures, lifestyle and medical history

Anthropometric measures (height, bodyweight) were recorded using a standardized protocol. The subjects completed a self-administered questionnaire that included their lifestyle and medical history.

Geriatric Depression Scale

The Geriatric Depression Scale (GDS) was used to evaluate depressive symptoms in the elderly people. Depressive symptoms were measured based on the Japanese version of the 30-item Geriatric Depression Scale (GDS 30), with a cut-off of 11.[8,9,13] We selected the cut-off of 11 because Schreiner *et al.* reported that the GDS cut-off score identified among Japanese participants was the same as that reported for Western participants using the 15-item GDS short form.[14] Each item was assessed by a yes/no question in one sentence. If the answering style tended to be depressive, we scored one point each, and summed up the 30 items. The maximum score was 30 points. The participants were further tested for cognitive ability based on the MMSE. Higher scores indicated higher cognitive function, and the maximum score was 30 points. The cognitive tests were conducted by trained personnel.

Pulse Wave Velocity measurement

Bilateral brachial-ankle pulse wave velocity (baPWV) was measured in all subjects, as an indicator of atherosclerosis, using the ankle-brachial pressure index (ABI)/pulse wave velocity (PWV) Form (Nihon Colin, Komaki, Japan), which incorporates an automatic oscillometer.[15] The ABI/PWV Form is a device with four cuffs that can simultaneously measure BP levels and pulse waves in both arms and both legs, and automatically calculates the ABI and baPWV. This device is useful for mass medical examinations and population-based studies because it enables measurement of PWV in a short time, and, more importantly, the measurement is non-invasive and is not affected by the operator's technique.[15] The validity, reproducibility and clinical significance of baPWV measurements have been reported previously.[16]

Statistical analyses

Based on the interview data, analyses of the distribution of OAB and the association of OAB with other factors were performed. The subjects were categorized into groups based on 26 factors, and significant differences in OAB prevalence were examined for each factor using logistic regression analysis; these factors included age, sex, depressive symptoms (GDS: 11 points or higher), history of comorbidities (stroke, hypertension, myocardial infarction, diabetes, cancer, kidney disease), smoking status, alcohol intake, body mass index (BMI), and baPWV. Regarding smoking, the subjects were divided into three groups: the never-smoking group (no history of smoking), the ex-smoking group and the current smoking group. In the same manner, they were also divided into three alcohol intake categories of never-drinker, ex-drinker and current drinker. For BMI, the subjects were divided into four groups: lean, <18.5; normal weight, ≥18.5 and <25; overweight, ≥25 and <30; and obese ≥30.

Table 1 General characteristics of the 833 subjects interviewed

Characteristics, *n* (%)	Men (*n* = 414)	Women (*n* = 419)	Total (*n* = 833)
OAB	73 (17.6)	80 (19.1)	153 (18.4)
Age (years)			
70–79	352 (42.3)	330 (39.6)	682 (81.9)
80–	62 (7.4)	89 (10.7)	151 (18.1)
GDS			
<11	338 (40.6)	282 (33.8)	620 (74.4)
≥11	76 (9.1)	137 (16.5)	213 (25.6)
Alcohol intake			
Never	71 (8.5)	292 (35.1)	363 (43.6)
Ex-drinker	62 (7.4)	37 (4.4)	99 (11.9)
Current drinker	281 (33.7)	90 (10.8)	371 (44.5)
Smoking status			
Never	85 (10.2)	382 (45.9)	467 (56.1)
Ex-smoker	252 (30.2)	27 (3.2)	279 (33.5)
Current smoker	77 (9.2)	10 (1.2)	87 (10.4)
BMI			
<18.5	22 (2.6)	24 (2.9)	46 (5.5)
≥18.5 and <25	244 (29.3)	227 (27.3)	517 (56.6)
≥25 and <30	134 (16.1)	145 (17.4)	279 (33.5)
>30	14 (1.7)	23 (2.8)	37 (4.4)
ABI			
≤0.9	29 (3.5)	19 (1.4)	41 (4.9)
>0.9	385 (46.2)	407 (48.8)	792 (95.1)
baPWV (m/s)			
<1.7	98 (11.8)	81 (9.7)	179 (21.5)
≥1.7 and <1.9	93 (11.1)	89 (10.7)	182 (21.8)
≥1.9 and <2.2	118 (14.2)	106 (12.7)	224 (26.9)
≥2.2	105 (12.6)	143 (17.2)	248 (29.8)
History/comorbidities			
Stroke	27 (3.2)	8 (1.0)	35 (4.2)
Hypertension	183 (22.0)	168 (20.2)	351 (42.1)
Myocardial infarction	58 (7.0)	33 (4.0)	91 (10.1)
Diabetes	72 (8.6)	51 (6.1)	123 (14.8)
Cancer	51 (6.1)	36 (4.3)	87 (10.4)
Kidney disease	23 (2.8)	33 (4.0)	56 (6.7)

ABI, ankle-brachial pressure index; baPWV, brachial-ankle pulse wave velocity; BMI, body mass index; GDS, Geriatric Depression Scale; OAB, overactive bladder.

The potential correlations between each of these factors and OAB were examined using univariate and multivariate logistic regression analysis. SAS software (version 9.0) was used for all statistical analyses.

Results

The baseline characteristics are shown in Table 1. Of the 833 subjects in the analysis, 414 (49.7%) were male. The mean age was 75.4 ± 4.5 years. A total of 153 people (18.4%) were diagnosed with OAB, including 73 men (17.6%) and 80 women (19.1%). Subjects with a GDS score of 11 or higher were included in the group with depressive symptoms; this group comprised 213 subjects (25.6%), including 76 men (18.4%) and 137 women (32.7%).

Univariate analysis showed that the prevalence of OAB was higher in participants with depressive symptoms than in those without, but no apparent correlations were observed between other factors and OAB (Table 2). Multiple adjusted logistic regression analysis was performed to examine the association between OAB and individual factors. The multiple adjusted odds ratio (OR) for having OAB was higher in