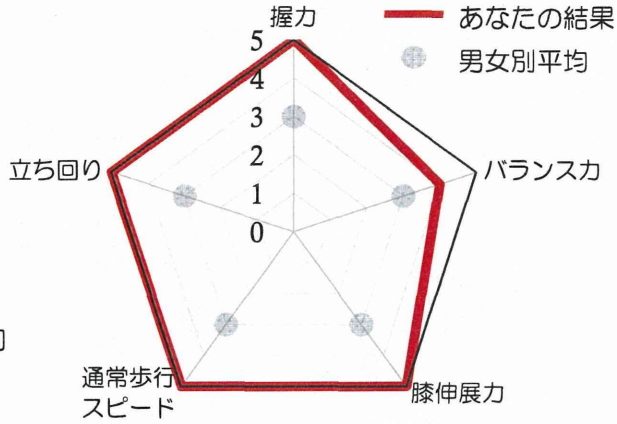
# からだのお達者度

| 項目 | 説明 | 結果 | ランク | 2年目 | 3年目 |
|---|---|---|---|---|---|
| 握力（kg） | 握る力 | 24 | 5 | - | - |
| バランス力（秒） | 平衡感覚がどれだけ保たれているのか | 36 | 4 | - | - |
| 膝伸展力（ニュートン） | 太もも前面の筋力 | 263 | 5 | - | - |
| 通常歩行スピード（秒） | 脚力全体（特にふくらはぎやすねの筋力） | 3.2 | 5 | - | - |
| 立ち回り（秒） | 歩行動作の総合力 | 5.4 | 5 | - | - |

## 動いたら、よく眠ってリラックス！

★★★
やりがい、生きがいを求めて
活動的に動く

★★
買い物がてら散歩を楽しむ
ゆくりした筋肉トレーニングも有効




◆虚弱（きょじゃく）になりやすい最たる原因に「筋肉減弱（サルコペニア）」があります。これは加齢性筋肉減少症ともいわれ、加齢、廃用（動かない）、様々な病気、低栄養などが原因で筋肉量と筋力が低下し、これらにより引き起こされる身体機能低下のことをいいます。虚弱になると、転倒や骨折しやすくなり、最終的には寝たきりになる恐れがあります。

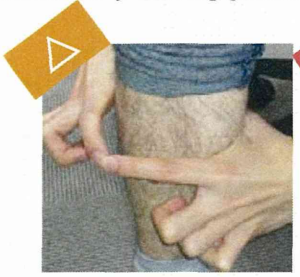
## あなたの筋肉量はどのくらい？

| 項目 | 説明 | 結果 | 2年目 | 3年目 |
|---|---|---|---|---|
| 四肢の筋肉量（kg/㎡） | 両手足すべての骨格筋量の総和を表します | 5.38 | - | - |

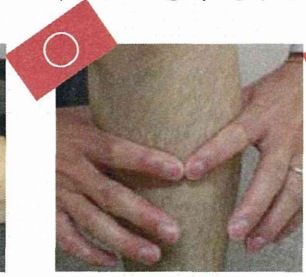
InBodyという機器で四肢の筋肉量を測定した数値を、体格（身長）で補正した数値です。筋力も重要ですが、筋肉量も重要です。今回の柏市の結果では、男性は、7を中心に±2ぐらいの範囲に、女性は、6を中心に±2ぐらいの範囲に分布しています。筋肉量は多い方が望ましいです。次回の測定に向けて減らないように頑張りましょう。

## ＜セルフチェック・コーナー＞
## 指輪っかテストで自分の筋肉量をチェックしてみよう！

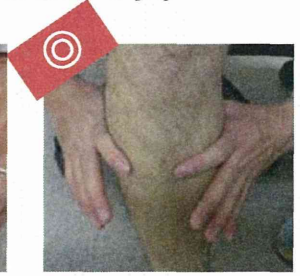
ふくらはぎ（下腿）部分の筋肉量を専門の検査を施行せずに、簡単に測定するために今回の調査から初めて考案されたものです。



隙間ができる



ちょうど囲める



囲めない

# 在宅医療ってなあに？？

在宅医療情報誌
準備号
わがや
MY SWEET HOME
発行：東京大学高齢社会総合研究機構　制作：白玉社

【お問い合わせ】東京大学高齢社会総合研究機構
〒113-8656 東京都文京区本郷 7-3-1 工学部 8 号館 703 号室
☎ 03-5841-1661　FAX：03-5841-1662
E-mail：info@iog.u-tokyo.ac.jp

在宅医療について、どのようなイメージをお持ちですか？やすらぎのあるわが家で、友人・家族に囲まれて、長年の努力と苦労の集大成を味わう充実期でしょうか。住みなれたわが家で、在宅医療を実現した本人や家族の満足感は高く、国民の６割が望んでいるといわれています。しかし人生の最期を、住みなれたわが家で迎えている方は、実はまだまだ少ない状況なのです。

介護や医療、在宅医療に関する疑問・質問、情報紙「わがや」のご意見ご感想をお寄せください。
編集部一同お待ちしております。

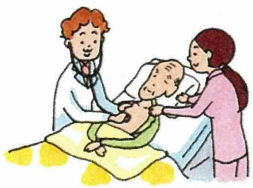
## 簡単チェックリスト　医療や介護どんな不安がありますか？

- ☐ 費用がたくさんかかりそう。
- ☐ 自分の意思で食べたり歩いたりが、できなくなりそう。
- ☐ （本人）家族に負担をかけそう。
- ☐ （家族）介護負担が重そうで憂うつになりそう。
- ☐ わが家では医療や介護を受けられなさそう。
- ☐ 不安が多いから施設に入ったら楽そうなのに、介護施設は一杯で入れなさそう。

１つでも当てはまった方。この情報誌はそんなあなたに役に立つ情報をお伝えいたします。

## 在宅医療 できること！ いいところ♪

ご自身で診てもらいたい医師を探して、自宅などで診てもらうことができます。



万が一、癌などで痛みがあるときでも、自宅などで痛みのコントロールをすることもできます。


状態によって、医師だけでなく、看護師、薬剤師、歯科医師、ヘルパーなどの多くの職種の人が自宅などに来て、ケアしてもらうことができます。

施設ではないので、自分の都合で外出したり、友達を呼んだり、家族と団らんができます。

## 我が家で過ごす

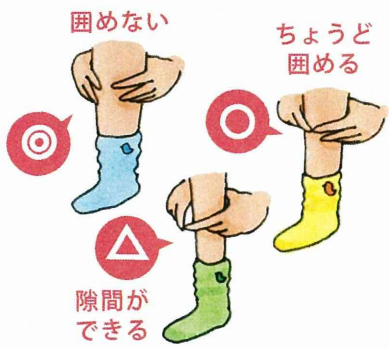
病気になると入院すれば医師や看護師がそばにいるので安心だと言う声をよく耳にします。でも入院生活は食事を始め様々な制約があります。これで本当に幸せでしょうか。入院は出来るだけ短くし住み慣れた我が家で過ごすのが一番です。できれば人生の最後も自宅で迎えたいものです。

柏市医師会
金江 清会長

## わが家で 地域で やってみよう！ 指「わっか」テスト編

### 指「わっか」テストとは？

ふくらはぎ（下腿）部分の筋肉量を専門の検査を行わず、簡単に測定するために今回はじめて考案したテストです。ご自分の筋肉量をチェックしてみましょう。




### 指「わっか」テストで何がわかるの？

虚弱になりやすい体質かどうかがわかります。虚弱化の原因に、「サルコペニア」とよばれる筋肉減弱があります。加齢、廃用（動かない）、様々な病気、低栄養などが原因で筋肉量と筋力が低下し、これらにより引き起こされる身体能力低下のことです。

虚弱になると、転倒や骨折しやすくなり、最終的に、寝たきりになることもあります。日ごろから、栄養のあるものを食べ、散歩をし、社会とのつながりを保ち、介護予防に心がけることが重要です。

東京大学高齢社会総合研究機構准教授・医師　飯島勝矢

## みんなで支える 在宅ケアのネットワーク

あなたが望めば、24 時間 365 日、あなたの自宅に専門家チームが伺います。医療保険、介護保険制度により、施設でも、病院でも、そしてわが家でも変わらぬケアが受けられます。


まんが在宅医療物語は柏市介護支援専門員協議会の皆様のご協力のもと、柏市での事例をもとに構成されています。

## ケアマネ渡辺さんのスリーステップ解説

### 1 当事者への理解

認知症高齢者は、もの忘れなどの中核的な症状に加え、不安感、ストレス等により、病気の進行に伴って、個人差はありますが、事例のような「ものとられ妄想」など様々な混乱した行動を起こしはじめることがあります。

### 2 家族の混乱

認知症発症後、Aさんのこれまでとは違ってしまった姿が目の前にあり、今までのAさんとの生活が変わっていくことへの怖さや、今後の介護負担がどの程度なのか、どのくらい続くのかの不安から混乱につながることが考えられます。

### 3 介護負担を軽減

ご家族の介護負担の軽減を図ることが重要ですが、まず、Aさんがどのような場所で生活し、どんな生活を望んでいるのかを把握しながら、訪問診療、介護サービス、インフォーマルなサービスを上手に組み合わせて、活用することが重要です。

## Dr.飯島のわがやの医学

### 「アルツハイマー型認知症」

脳内で特殊なタンパク質異常が起こり、脳内の神経細胞がどんどん壊れ、脳が次第に萎縮していく病気です。複数ある認知症のタイプのうち約半分を占めます。高齢化に伴い、女性に多く発症しています。発症と進行は比較的緩やかですが、徐々に悪化していきます。多くの場合、物忘れ（記憶障害）から始まり、最終的には身体全体の機能も衰えていき、寝たきりに向かってしまいます。

■ 次号の「わがや」は6月頃発行予定です

研究成果の刊行に関する一覧表

主任研究者
飯島勝矢
雑誌

| 発表者氏名 | 論文タイトル名 | 発表誌名 | 巻号 | ページ | 出版年 |
|---|---|---|---|---|---|
| Iijima K, Iimuro S, Shinozaki T, Ohashi Y, Sakurai T, Umegaki H, ArakiA, Ouchi Y, Ito H, J-EDIT Investigator Group | Lower Physical Activity is a Strong Predictor of Cardiovascular Events in Elderly Patients with Type 2 Diabetes Mellitus beyond Traditional Risk Factors: Japanese Elderly Diabetes Intervention Trial (J-EDIT) | GeriatrGerontol Int. | 12 Suppl. 1 | 77-87 | 2012 |
| Iijima K, Iimuro S, Ohashi Y, Sakurai T, Umegaki H, Araki A, Yoshimura Y, Ouchi Y, Ito H, J-EDIT Investigator Group | Lower Physical Activity, but not Excessive Calorie Intake, is Associated with Metabolic Syndrome in Elderly with Type 2 Diabetes Mellitus: Japanese Elderly Diabetes Intervention Trial (J-EDIT) | GeriatrGerontol Int. | 12 Suppl. 1 | 68-76 | 2012 |
| Kojima T, Akishita M, Nakamura T, Nomura K, Ogawa S, Iijima K, Eto M, Ouchi Y | Polypharmacy as a risk for fall occurrence in geriatric outpatients | GeriatrGerontol Int. | 12 | 425-430 | 2012 |
| Son BK, AkishitaM,Iijima K, Ogawa S, Arai T, Ishii H, MaemuraK, Aburatani H, Eto M, Ouchi Y. | Thrombomodulin, a novel molecule regulating inorganic phosphate-induced vascular smooth muscle cell calcification. | Mol Cell Cardiol | 56 | 72-80 | 2013 |
| Inajima T, Imai Y, Morita H, Nagai R, Iijima K, Yanagimoto S, Yahagi N, Lopez G, Shuzo M, Yamada I | Relation Between Blood Pressure Estimated by Pulse WaveVelocity and Directly Measured Arterial Pressure | Journal of Robotics and Mechatronics | Vol.24 No.5 | 811-819 | 2012 |
| Takahashi T, Matsumoto S, Iijima K, Morimoto S | Guidelines for Nonmedical Care Providers to Manage the First Step of EmergencyTriage of | J Experimental and Clinical Medicine | 59(11) | 2189-91 | 2012 |

| | | | | | |
|---|---|---|---|---|---|
| | Elderly Evacuees: Downloaded via Smart Phones in Japan | | | | |
| Hibi S, Yamaguchi Y, Umeda-Kameyama Y, Yamamoto H, IijimaK, Momose T, Akishita M, Ouchi Y | The high frequency of periodic limb movements in patients with Lewy body dementia | J Psychiatr Res. | 46 | 1590-1594 | 2012 |
| Araki A, Iimuro S, Ohashi Y, Iijima K, Sakurai T, Umegaki H, Ito H, J-EDIT Investigator Group | Non-high-density lipoprotein cholesterol: an important predictor of stroke and diabetes-related mortality in Japanese elderly diabetic patients | GeriatrGerontol Int. | 12 Suppl. 1 | 18-28 | 2012 |
| Araki A, Iimuro S, Ohashi Y, Iijima K, Sakurai T, Umegaki H, Ito H, J-EDIT Investigator Group | Long-term multiple risk factor intervention in Japanese elderly diabetic patients: The Japanese Elderly Diabetes Intervention Trial (J-EDIT)-study design, baseline characteristics, and effects of intervention | GeriatrGerontol Int. | 12 Suppl. 1 | 7-17 | 2012 |
| Umegaki H, Iimuro S, Ohashi Y, Iijima K, Sakurai T, Araki A, Ito H, J-EDIT Investigator Group | Risk factors associated with cognitive decline in the elderly with type 2 diabetes: Pooled logistic analysis of a 6-year observation in the Japanese Elderly Diabetes Intervention Trial (J-EDIT). | GeriatrGerontol Int. | 12 Suppl. 1 | 110-116 | 2012 |
| Umegaki H, Iimuro S, Ohashi Y, Iijima K, Sakurai T, Araki A, Ito H, J-EDIT Investigator Group | Risk factors associated with cognitive decline in the elderly with type 2 diabetes: Baselinedata analysis of Japanese Elderly Diabetes Intervention Trial (J-EDIT) | GeriatrGerontol Int. | 12 Suppl. 1 | 103-109 | 2012 |
| Iimuro S, Ohashi Y, Iijima K, Sakurai T, Umegaki H, Araki A, Ito H, J-EDIT Investigator Group | Dietary pattern and mortality in Japanese elderly patients with type 2 diabetes mellitus -Does vegetable- and fish-rich diet improve mortality ?: An explanatory study | GeriatrGerontol Int. | 12 Suppl. 1 | 59-67 | 2012 |
| Ota H, Akishita M, Akiyoshi T, Kahyo T, | Testosterone Deficiency Accelerates Neuronal and | PLoS One. | 7(1) | e29598 | 2012 |

| | | | | | |
|---|---|---|---|---|---|
| Setou M, Ogawa S, Iijima K, Eto M, Ouchi Y | Vascular Aging of SAMP8 Mice: Protective Role of eNOS and SIRT1 | | | | |
| 飯島勝矢，亀山祐美，秋下雅弘，大内尉義，柳元伸太郎，今井靖，矢作直樹，Lopez Guillaume，酒造正樹，山田一郎 | 高齢者におけるウェアラブル血圧センサーの臨床応用：～認知機能およびストレス感受性からみた血圧短期変動評価への有用性の検討～ | 人工知能学会論文誌 | 27 | 40-45 | 2012 |
| 飯島勝矢 | 高齢者における身体活動量(Physical Activity)の意義 | 日本老年医学会雑誌 第54回日本老年医学会学術集会シンポジウム8 高齢者糖尿病の管理－J-EDITから得られたもの－ | 50(1) | 56-59 | 2012 |
| 飯島勝矢 | 何が求められているのか？ 千葉県柏市・健康長寿都市計画から：～『Aging in Place』を目指して～ | 日本老年医学会雑誌 第54回日本老年医学会学術集会公開シンポジウム「超高齢社会における街(都市)づくり」 | 49(6) | 693-696 | 2012 |
| 飯島勝矢，吉江悟，木全真理，井堀幹夫，山本拓真，後藤純，柴崎孝二，藤田伸輔，高林克日己，鎌田実，辻哲夫 | 在宅医療推進における円滑な情報共有システムを導入した新たな多職種連携の試み：千葉県柏市における | 在宅医療の推進．癌と化学療法 | 39(Suppl. I) | 51-54 | 2012 |

書籍

| 著者氏名 | 論文タイトル名 | 書籍全体の編集者名 | 書籍名 | 出版社名 | 出版地 | 出版年 | ページ |
|---|---|---|---|---|---|---|---|
| 飯島勝矢 | 循環器疾患患者の栄養管理 | 大村健二・葛谷雅文 | 高齢者の栄養 | 株式会社羊土社 | 東京 | 2013 | 89-95 |

分担研究者

大内尉義

雑誌

| 発表者氏名 | 論文タイトル名 | 発表誌名 | 巻号 | ページ | 出版年 |
|---|---|---|---|---|---|
| Arai H, Ouchi Y, Yokode M, Ito H, Uematsu H, Eto F, Oshima S, Ota K, Saito Y, Sasaki H, Tsubota K, Fukuyama H, Honda Y, Iguchi A, Toba K, Hosoi T, Kita T; Members of Subcommittee for Aging | Toward the realization of a better aged society: messages from gerontology and geriatrics | GeriatrGerontol Int. | 12 | 16-22 | 2012 |
| Akishita M, Ishii S, Kojima T, Kozaki K, Kuzuya M, Arai H, Arai H, Eto M, Takahashi R, Endo H, Horie S, Ezawa K, Kawai S, Takehisa Y, Mikami H, Takegawa S, Morita A, Kamata M, Ouchi Y, Toba K | Priorities of healthcare outcomes for the elderly | J Am Med DirAssoc | | | 印刷中 |
| Ishii S, Cauley JA, Greendale GA, Crandall CJ, Danielson ME, Ouchi Y, Karlamangla AS | C-Reactive Protein, Bone strength, and 9-year fracturerRisk: Data from the study of women's health Across the nation (SWAN) | J Bone Miner Res | | | 印刷中 |
| Yu J, Akishita M, Eto M, Koizumi H, Hashimoto R, Ogawa S, Tanaka K, Ouchi Y, Okabe T. | Src kinase-mediates androgen receptor-dependent non-genomic activation of signaling cascade leading to endothelial nitric oxide synthase | BiochemBiophys Res Commun | 424 | 538-43 | 2012 |
| Iijima K, Iimuro S, Shinozaki T, Ohashi Y, Sakurai T, Umegaki H, ArakiA, Ouchi Y, Ito H, J-EDIT Investigator Group | Lower Physical Activity is a Strong Predictor of Cardiovascular Events in Elderly Patients with Type 2 Diabetes Mellitus beyond Traditional Risk Factors: Japanese Elderly Diabetes Intervention Trial (J-EDIT) | GeriatrGerontol Int. | 12 Suppl. 1 | 77-87 | 2012 |
| Iijima K, Iimuro S, Ohashi Y, Sakurai T, Umegaki H, Araki A, Yoshimura Y, | Lower Physical Activity, but not Excessive Calorie Intake, is Associated with Metabolic | GeriatrGerontol Int. | 12 Suppl. 1 | 68-76 | 2012 |

| | | | | | |
|---|---|---|---|---|---|
| Ouchi Y, Ito H, J-EDIT Investigator Group | Syndrome in Elderly with Type 2 Diabetes Mellitus: Japanese Elderly Diabetes Intervention Trial (J-EDIT) | | | | |
| Kojima T, Akishita M, Nakamura T, Nomura K, Ogawa S, Iijima K, Eto M, Ouchi Y | Polypharmacy as a risk for fall occurrence in geriatric outpatients | GeriatrGerontol Int. | 12 | 425-430 | 2012 |
| Son BK, Akishita M, Iijima K, Ogawa S, Arai T, Ishii H, MaemuraK, Aburatani H, Eto M, Ouchi Y | Thrombomodulin, a novel molecule regulating inorganic phosphate-induced vascular smooth muscle cell calcification. | Mol Cell Cardiol. | 56 | 72-80 | 2013 |
| Hibi S, Yamaguchi Y, Umeda-Kameyama Y, Yamamoto H, Iijima K, Momose T, Akishita M, Ouchi Y | The high frequency of periodic limb movements in patients with Lewy body dementia | J Psychiatr Res. | 46 | 1590-1594 | 2012 |
| Ota H, Akishita M, Akiyoshi T, Kahyo T, Setou M, Ogawa S, Iijima K, Eto M, Ouchi Y | Testosterone Deficiency Accelerates Neuronal and Vascular Aging of SAMP8 Mice: Protective Role of eNOS and SIRT1 | PLoS One. | 7(1) | e29598 | 2012 |
| 飯島勝矢，亀山祐美，秋下雅弘，大内尉義，柳元伸太郎，今井靖，矢作直樹，Lopez Guillaume，酒造正樹，山田一郎 | 高齢者におけるウェアラブル血圧センサーの臨床応用：～認知機能およびストレス感受性からみた血圧短期変動評価への有用性の検討～ | 人工知能学会論文誌 | 27 | 40-45 | 2012 |

菊谷武

雑誌

| 発表者氏名 | 論文タイトル名 | 発表誌名 | 巻号 | ページ | 出版年 |
|---|---|---|---|---|---|
| Takahashi N, Kikutani T, Tamura F, Groher M, Kuboki T. | Videoendoscopic assessment of swallowing function to predict the future incidence of pneumonia of the elderly. | Journal of Oral Rehabilitation | 39(6) | 429-437 | 2012 |
| Kikutani T, Tamura F, Tohara T, Takahashi N, Yaegaki K. | Tooth loss as risk factor for foreign-body asphyxiation in nursing-home patients | Arch GerontolGeriatr | 18-Feb | | 2012 |

| | | | | | |
|---|---|---|---|---|---|
| Kikutani T, Yoshida M, Enoki H, Yamashita Y, Akifusa S, Shimazaki Y, Hirano H, Tamura F. | Relationship between nutrition status and dental occlusion in community-dwelling frail elderly people | GeriatrGerontol Int | | 50-54 | 2013 |
| 菊谷 武 | 歯科におけるNSTの可能性 | ヒューマンニュートリション | No.17 | 26-27 | 2012 |
| 菊谷 武 | Ⅰ地域医療における摂食・嚥下リハビリテーション1.地域を支える摂食・嚥下リハビリテーション | 歯科医療2012夏号 | 26(3) | 4-7 | 2012 |

書籍

| 著者氏名 | 論文タイトル名 | 書籍全体の編集者名 | 書籍名 | 出版社名 | 出版地 | 出版年 | ページ |
|---|---|---|---|---|---|---|---|
| 菊谷 武 | | | 「食べる」介護がまるごとわかる本 ー食事介助の困りごと解決法から正しい口腔ケアまで、全部教えます | 株式会社メディカ出版 | 大阪 | 2012 | |

大渕修一

雑誌

| 発表者氏名 | 論文タイトル名 | 発表誌名 | 巻号 | ページ | 出版年 |
|---|---|---|---|---|---|
| 新井武志、大渕修一、小島成実、柴喜崇、河合恒、大室和也 | ジャイロセンサを用いた膝関節伸展角速度測定値の適用可能性-介護予防事業対象者における検証- | 理学療法科学 | | | 印刷中 |
| 小島基永、大渕修一 | 地域在住虚弱高齢者に対する筋力増強トレーニングの最適負荷見極めにおける、加速度時系列スペクトルのエントロピーの有用性の検討 | 理学療法科学 | 27(3) | 291-296 | 2012 |

書籍

| 著者氏名 | 論文タイトル名 | 書籍全体の編集者名 | 書籍名 | 出版社名 | 出版地 | 出版年 | ページ |
|---|---|---|---|---|---|---|---|
| 大渕修一 | | 小林弘美 | 一生ボケない寝たきりにならない方法 | 株式会社学研パブリッシング | 東京 | 2013 | 208 |

Geriatrics Gerontology 1st Impact Factor in June 2010 Medline Indexed

*Geriatr Gerontol Int 2012;* **12 (Suppl. 1):** *77–87*

ORIGINAL ARTICLE

# Lower physical activity is a strong predictor of cardiovascular events in elderly patients with type 2 diabetes mellitus beyond traditional risk factors: The Japanese elderly diabetes intervention trial

Katsuya Iijima,[1,2] Satoshi Iimuro,[3] Tomohiro Shinozaki,[3] Yasuo Ohashi,[3] Takashi Sakurai,[4,5] Hiroyuki Umegaki,[6] Atsushi Araki,[7] Yasuyoshi Ouchi,[1] Hideki Ito[6] and the Japanese Elderly Diabetes Intervention Trial Investigator Group*

*[1]Department of Geriatric Medicine, Graduate School of Medicine, [2]Institute of Gerontology, [3]Department of Biostatistics, School of Public Health, Graduate School of Medicine, the University of Tokyo, Tokyo, [4]Department of Diabetes Mellitus, Metabolism and Endocrinology, Tokyo Metropolitan Geriatric Hospital, Tokyo, [5]Center for Comprehensive Care and Research on Demented Disorders, National Center for Geriatrics and Gerontology, Oobu, Aichi, [6]Department of Geriatric Medicine, Graduate School of Medicine, University of Kobe, Kobe, [7]Department of Community Healthcare and Geriatrics, Graduate School of Medicine, University of Nagoya, Nagoya, Japan*

**Aim:** It is well known that a decline in physical activity is associated with lifestyle-related diseases including cardiovascular (CV) events. However, little is known about the association between physical activity and CV events in elderly patients, because recent accumulating reports have mainly dealt with middle-aged populations. In this study, we investigated the correlation between physical activity and CV events in Japanese elderly patients with type 2 diabetes mellitus (T2DM).

**Methods:** A total of 938 Japanese elderly patients with T2DM (447 men and 491 women, mean age 71.9 years) enrolled (2000–2002) in the Japanese Elderly Diabetes Intervention Trial (J-EDIT) were used in this study. Physical activity consisting of three components, work, sports and leisure-time, of their lifestyle was evaluated using the Baecke questionnaire at baseline. Total activity score (TAS) as a sum of each activity score was divided into four quartiles (Q1 to Q4).

**Results:** During a follow-up period of 65.2 months, 165 events and 71 deaths in total occurred. Higher TAS grade was associated with reduced risk of all events (hazard ratios: 0.82, 0.77 and 0.54 in Q2, Q3 and Q4, respectively) with statistical significance. Even after multivariate adjustment for covariates, higher TAS grade was a strong predictor of all events, and the prediction by TAS of cerebrovascular events was more effective than that

Accepted for publication 7 November 2011.

Correspondence: Dr Katsuya Iijima MD PhD, Department of Geriatric Medicine, Graduate School of Medicine, the University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan. Email: katsu-tky@umin.ac.jp

**The J-EDIT Study Group:* Principal Investigator: Hideki Ito M.D., Ph.D., Department of Diabetes, Metabolism and Endocrinology, Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology, 35-2 Sakae-cho, Itabashi-ku, Tokyo 173-0015, Japan.



doi: 10.1111/j.1447-0594.2011.00815.x

of cardiac events. In contrast, all-cause mortality gradually decreased according to TAS grade; however, no statistical significance was found. Among the four grades of TAS, no significant change in several parameters, such as profiles of lipid and glucose metabolism, blood pressure, physical measurements, cognitive function and depression scale, was found throughout the follow-up period, suggesting that the higher level of physical activity itself was associated with the risk reduction of primary events.

**Conclusion:** Lower physical activity is a strong and independent predictor of all CV events in the elderly with T2DM beyond traditional risk factors. In addition to strict management of each atherosclerotic risk factor, engagement with patients to augment and maintain the level of physical activity in their lifestyle is also essential in clinical practice.
**Geriatr Gerontol Int 2012; 12 (Suppl. 1): 77–87.**

**Keywords:** elderly, engagement in physical activity, Japanese Elderly Diabetes Intervention Trial study, physical activity, risk reduction, type 2 diabetes mellitus.

## Background

A decline in physical activity has been shown to lead to increased risk of several cardiovascular (CV) diseases, such as cerebrovascular disease (CVD) and coronary heart disease (CHD).[1–6] In developed countries, 80% of all deaths from CV disease occur in people aged 65 years and older.[7] Unfortunately, 60% or more of USA adults are not physically active in their lifestyle.[8] Accordingly, in 1995 the Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM) recommended a moderate amount of physical activity on most days, and preferably all days, of the week.[9] However, the precise mechanisms through which physical activity lowers the risk of CV disease are not well understood.

Little is known about the crucial correlation between physical activity and CV events in elderly patients, because recent accumulating reports have mainly dealt with middle-aged populations. In fact, the evidence as a whole has been derived from studies targeting the middle-aged and the elderly combined, including three previous studies in Japan.[10–12] In addition, few studies have evaluated the association between physical activity and long-term outcomes in Japanese. The Framingham Heart Study showed an inverse association between physical activity and mortality risk as a result of CV disease, even in 285 elderly individuals.[13] However, no statistical significance was reached, possibly as a result of the limited number of events. To our knowledge, how effective and beneficial encouragement of physical activity is in the elderly is still controversial. In general, although activity has been believed to be beneficial even in the elderly,[14–16] some studies have emphasized that physical activity might be harmful to the elderly.[13,17] Therefore, it is essential to investigate the precise association of physical activity with CV events and mortality in Japanese elderly patients.

In the present study, the correlation between grade of physical activity and events (all CV events and all-cause mortality) was investigated in Japanese elderly patients with type 2 diabetes mellitus (T2DM). In addition, analysis was also carried out to address which component was more effective as a good predictor.

## Methods

### *Study population*

The subjects were participants who were enrolled in the Japanese Elderly Diabetic Intervention Trial (J-EDIT), a randomized, double-blind, recently completed trial of intensive or standard treatment of diabetes for the prevention of CV disease in elderly patients with T2DM. J-EDIT involved 1173 diabetic subjects who were aged 65 years or older (mean age 71.8 ± 4.6 years) and whose serum glycated hemoglobin A1c (HbA1c) level was >7.4% from 39 institutions and hospitals (the University of Tokyo Hospital, Kobe University Hospital, Nagoya University Hospital and Tokyo Metropolitan Geriatric Hospital etc.) in Japan. Written informed consent was obtained from all patients.

From among these patients enrolled in the J-EDIT, we selected 938 patients in whom complete data regarding physical activity (Baecke physical activity questionnaire) were obtained at baseline. We excluded participants who had difficulty communicating, dementia or serious deterioration of activities of daily living (ADL).

### *Physical activity assessed by Baecke questionnaire*

To evaluate physical activity at enrolment in this trial, Baecke physical activity questionnaire was carried out as previously reported.[18,19] The reliability of this score has been confirmed by many previous reports. Therefore, it is suggested that it might be a valuable monitoring tool for assessing the association of multiple domains of physical activity with the metabolic syndrome (MetS) in elderly patients with T2DM, with acceptable reliability and validity. The activity score is classified into three

domains: work activity, sports activity and non-sporting leisure activity. These three components consisted of items on the frequency, duration, average amount of time spent weekly on walking, hobbies and so on, and the average amount of time spent on odd jobs and sports monthly. The types of odd jobs, sports and hobbies (e.g. dancing, gardening or fishing) were also assessed.

In analyses, each component was also divided into several groups as follows: three groups in "work activity" score (WAS; None: =0, Low: ≥1 and <3.25, High: >3.25), two groups in "sports activity" score (SAS; Low: <4.0, High: ≥4.0), and four groups (quartiles) in "non-sporting leisure-time activity" score (LTAS; L-Q1: <2.0, L-Q2: ≥2.0 and <2.25, L-Q3: ≥2.25 and <2.75, L-Q4: ≥2.75). Scores from each component were summed to yield total physical activity score (TAS; maximum 15 points). TAS was divided into four quartiles (Q1 to Q4) as follows: Q1: <5.7, Q2: ≥5.7 and <7.7, Q3: ≥7.7 and <10.5, Q4: ≥10.5.

### *Physical measurement, cognitive function, ADL and mood status*

At enrolment, body mass index (BMI) was calculated by physical measurement of body height and weight. Both waist circumference and hip circumference were also measured, and waist-to-hip ratio (W/H ratio) was calculated. Cognitive function was determined by Mini-Mental State Examination (MMSE). Each basic or instrumental ADL was determined by Barthel index or Tokyo Metropolitan Institute of Gerontology (TMIG) index,[21] respectively. Mood status was checked using the Geriatric Depression Scale (GDS-15).

### *Blood pressure and laboratory measurements*

Blood pressure (BP) was measured in the clinic. Laboratory data obtained from blood sample collection at enrolment included lipid profile (total cholesterol [TC]), high-density lipoprotein cholesterol (HDL-C), triglyceride (TG) and low-density lipoprotein cholesterol (LDL-C; calculated by Friedewald equation: TC-HDL-C-TG/5), profile of glucose metabolism (fasting blood glucose; FBS, HbA1c, fasting insulin concentration [FIRI]), and renal function (serum creatinine). All parameters were obtained every year. Changes in each parameter were calculated as the difference between baseline and end of follow up.

### *Clinical outcomes*

Patients in the present study were continuously monitored for the occurrence of all events and deaths. In this trial, the CV events according to our definition were specified clearly as cardiac events including coronary heart disease (CHD; angina pectoris and myocardial infarction), cerebrovascular disease (CVD) including transient ischemic attack (TIA), stroke and cerebral hemorrhage, peripheral artery disease (PAD), and heart failure (HF). Individual diagnoses were classified according to the 9th International Classification of Disease (ICD-9) codes. We also classified each event into diabetes-related events (CHD, CVD, coronary revascularization, heart failure, sudden death, renal death, diabetic foot) and diabetes-independent events.

### *Statistical analysis*

Differences in baseline characteristics across the four quartiles of physical activity (Q1 to Q4) were evaluated using analysis of variance for normally distributed variables. *P*-values for sex and previous CHD/CVD were calculated based on the Cochran–Armitage trend test, and others were based on the linear contrast test. Event-free survival during the follow-up period was analyzed using Kaplan–Meier curves and log–rank test. Hazard ratios (HR) for all CV events and all-cause deaths were analyzed using a Cox proportional hazards model. HR, 95% confidence intervals (CI) and *P*-values were presented using the lowest quartile (Q1) as the reference category.

## Results

### *Baseline characteristics*

The baseline characteristics of all the eligible subjects ($n = 938$) are shown according to TAS category, which was divided into four quartiles (Q1 to Q4), in Table 1.

First, patients with higher TAS grade tended to be slightly younger. Scores of each of the three components (work, sports and non-sporting leisure time) were positively associated with TAS. No significant association between BP and TAS was observed. In the lipid profile, HDL-C and TG were positively correlated with TAS grade (*P*-value for trend: $P = 0.021$ and $P = 0.028$, respectively); however, other lipid parameters (TC and LDL-C) showed no statistical significance. In addition, serum creatinine also tended to be lower according to TAS grade; however, the difference was very slight. Each parameter of glucose metabolism showed no statistical significance between the four quartiles of TAS.

With regard to physical measurements, TAS was negatively associated with waist circumference. BMI and hip circumference also tended to be associated with TAS grade, but without statistical significance.

Cognitive function, as determined by MMSE score, was higher according to increasing TAS grade. TMIG index as instrumental ADL also showed a similar positive association; however, Barthel index as basic ADL did not (data not shown). In addition, GDS-15 score as

**Table 1** Baseline characteristics of study subjects according to total physical activity score category

| | All ($n$ = 938) | TAS category Quartile 1 ($n$ = 232) | Quartile 2 ($n$ = 229) | Quartile 3 ($n$ = 230) | Quartile 4 ($n$ = 247) | $P$-values for linear trend |
|---|---|---|---|---|---|---|
| Sex (male)* | 447 (47.7) | 110 (47.4) | 109 (47.6) | 115 (50.0) | 113 (45.7) | 0.841 |
| Age at baseline (years)† | 71.9 (4.7) | 72.7 (4.8) | 72.1 (4.8) | 72.1 (4.7) | 70.8 (4.2) | <.0001 |
| TAS (total) | 7.7 (3.0) | 3.6 (1.4) | 6.6 (0.6) | 9.0 (0.9) | 11.3 (0.6) | <.0001 |
| WAS (work) | 2.1 (1.6) | 1.1 (1.4) | 2.1 (1.7) | 1.7 (1.5) | 3.3 (0.4) | <.0001 |
| SS (sports) | 2.8 (2.3) | 0.1 (0.5) | 1.8 (2.2) | 4.5 (0.9) | 4.8 (0.3) | <.0001 |
| LTS (leisure-time) | 2.8 (0.6) | 2.4 (0.5) | 2.7 (0.4) | 2.9 (0.6) | 3.2 (0.4) | <.0001 |
| SBP (mmHg)† | 137.1 (16.3) | 137.8 (15.8) | 137.2 (17) | 137.2 (16.1) | 136.2 (16.2) | 0.310 |
| DBP (mmHg)† | 75.0 (9.9) | 75.2 (10.4) | 75.1 (10.1) | 74.8 (10.0) | 75.0 (9.1) | 0.765 |
| PP (mmHg)† | 62.1 (13.6) | 62.6 (14.1) | 62.3 (13.5) | 62.3 (13.7) | 61.2 (13.2) | 0.291 |
| T-chol (mg/dL)† | 203.3 (34.7) | 202.4 (35.4) | 205.7 (37.3) | 202.8 (30.1) | 202.4 (35.6) | 0.770 |
| HDL-C (mg/dL)† | 56.4 (17.9) | 53.3 (15.9) | 56.8 (17.8) | 56.3 (19.3) | 58.9 (18.2) | 0.002 |
| LDL-C (mg/dL)† | 121.0 (30.6) | 120.8 (31.5) | 123.3 (31.8) | 120.9 (28.0) | 119.1 (31.0) | 0.393 |
| TG (mg/dL)† | 133.4 (94.1) | 143.3 (86.8) | 135.2 (128.9) | 130.6 (79) | 124.9 (72.6) | 0.028 |
| sCr (mg/dL)† | 0.8 (0.3) | 0.9 (0.4) | 0.8 (0.4) | 0.8 (0.3) | 0.8 (0.2) | <.0001 |
| FBS (mg/dL)† | 167.4 (50.6) | 172.9 (56.4) | 168 (51.3) | 168.4 (50.0) | 161.1 (44.1) | 0.019 |
| FIRI (mg/dL)† | 10.3 (10.4) | 12.8 (13.9) | 10.5 (10.2) | 9.2 (8.3) | 9.2 (8.3) | 0.001 |
| HbA1c (%)† | 8.5 (1.3) | 8.4 (1.2) | 8.5 (1.3) | 8.4 (1.3) | 8.5 (1.2) | 0.767 |
| BMI (kg/m$^2$)† | 23.9 (3.5) | 24.5 (3.8) | 24 (3.5) | 23.6 (3.4) | 23.5 (3.1) | 0.002 |
| Waist circumference (cm)† | 84 (10.3) | 86 (10.7) | 84.2 (9.6) | 83.4 (10.6) | 82.6 (9.9) | 0.0002 |
| Hip circumference (cm)† | 93.9 (8.1) | 94.9 (8.5) | 94.1 (7.8) | 93.2 (7.9) | 93.4 (7.9) | 0.022 |
| W/H ratio† | 0.9 (0.1) | 0.9 (0.1) | 0.9 (0.1) | 0.9 (0.1) | 0.9 (0.1) | 0.001 |
| MMSE† | 27.9 (2.6) | 27.4 (3.3) | 27.8 (2.4) | 28.1 (2.4) | 28.5 (2.1) | <.0001 |
| Barthel index†‡ | 19.8 (1.1) | 19.6 (1.7) | 19.8 (1.2) | 19.8 (0.6) | 19.9 (0.3) | 0.004 |
| TMIG index†‡ | 11.6 (2.2) | 10.5 (3.1) | 11.6 (2.0) | 11.9 (1.7) | 12.3 (1.3) | <.0001 |
| GDS-15†‡ | 4.1 (3.2) | 5.3 (3.4) | 4.4 (3.2) | 3.8 (3.0) | 3.1 (2.8) | <.0001 |
| Previous CHD* | 154 (16.4) | 33 (14.2) | 44 (19.2) | 42 (18.3) | 35 (14.2) | 0.005 |
| Previous CVD* | 123 (13.1) | 38 (16.4) | 33 (14.4) | 34 (14.8) | 18 (7.3) | 0.005 |

*$n$ (%). †Mean (SD). ‡Mini-Mental State Examination (MMSE), Barthel index, Tokyo Metropolitan Institute of Gerontology (TMIG) index, and Geriatric Depression Scale (GDS)-15 are on a scale of 0 to 30, 0 to 20, 0 to 13, and 0 to 15, respectively. $P$-value for sex, previous coronary heart disease (CHD), and previous cerebrovascular disease (CVD) were calculated based on the Cochran-Armitage trend test, and others were based on the linear contrast test. BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood glucose; FIRI, fasting insulin resistance index; HbA1c, glycated hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LTS, leisure-time activity score; PP, pulse pressure; SBP, systolic blood pressure; sCr, serum creatinine; SS, sports score; TAS, total activity score; T-chol, total cholesterol; TG, triglyceride; W/H ratio, waist-to-hip circumference ratio; WAS, work activity score.

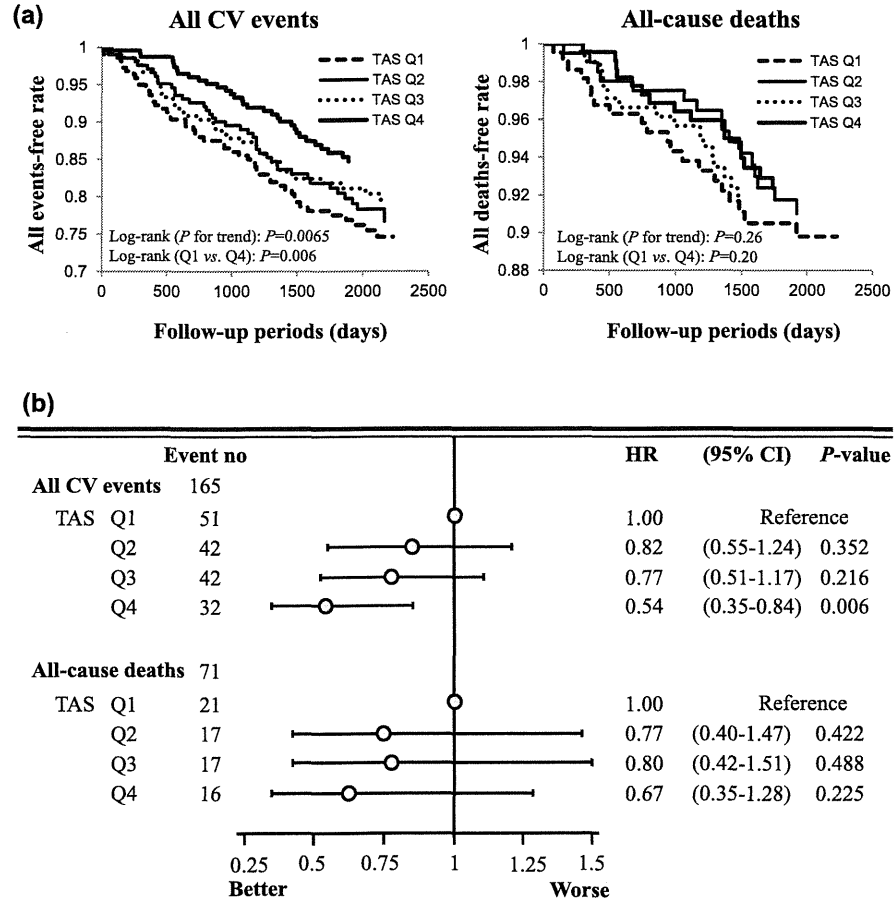



**Figure 1** Kaplan–Meier analysis of incidence of all cardiovascular (CV) events and all-cause deaths, and significant risk reduction by higher total activity score (TAS) grade. (a) Kaplan–Meier analysis shows the incidence of all CV events and all-cause deaths. Few primary events of statistical significance were found in the higher TAS group. In contrast to all CV events, all-cause deaths gradually decreased according to TAS grade; however, no statistical significance was found. (b) Before adjustment, hazard ratios (HR) for all CV events and all-cause deaths using a Cox proportional hazards model showed a significant risk reduction with higher TAS grade. Q, quartile.

mood status showed an inverse association with TAS grade, suggesting an association between lower activity and depressive mood.

Regarding previous CHD, there was no significant difference among the groups. In contrast, previous CVD was less frequent in the TAS Q4 group.

### *Incidence of events during follow-up period*

During the follow-up period of approximately 6 years (average 65.2 months), 165 all-CV events and 71 deaths in total occurred. All CV events, defined as a first event, included 45 CHD events (10 fatal and 35 non-fatal), 52 CVD events (4 fatal and 48 non-fatal), 29 diabetes-related events (9 fatal and 20 non-fatal) other than CHD and CVD, and 39 fatal diabetes-independent events. All-deaths included 11 deaths from CHD, four deaths from CVD, 11 diabetes-related deaths and 45 diabetes-independent deaths.

According to TAS grade, the incidence of these events was evaluated in all participants. As shown in Figure 1a, few all-CV events were found in the higher TAS group with statistical significance (log–rank test; $P = 0.0065$). In contrast to all-CV events, all-cause deaths gradually decreased according to TAS grade; however, no statistical significance was found. In analysis without adjustment, HR of each TAS grade were 0.82, 0.77 and 0.54 in Q2, Q3 and Q4, respectively, compared with Q1 as reference (*P*-value for trend; $P = 0.006$; Fig. 1b). In comparison between the lowest group (Q1) and highest group (Q4), a significant difference in incidence of first events was found from the early phase after randomization (log–rank test [Q1 *vs* Q4]; $P = 0.006$).

To determine how several parameters or TAS contributed to the reduction in all events, we carried out additional analysis after adjustment for several variables as potential confounders (Table 2). Among some variables except TAS, statistical significance was found for HbA1c, age and sex (female). Strikingly, TAS showed strong predictive power for all CV events. HR of each TAS grade were 0.74, 0.77 and 0.62 in Q2, Q3 and Q4, respectively, compared with Q1 as reference, and Q4 group statistically showed a significance ($P = 0.037$). However, variables including TAS except age and sex (female) were not associated with all-cause deaths. After addition of each of previous CVD or CHD to these adjusting variables, HR was 1.52 in previous CVD (95% CI 1.06–2.41, $P = 0.1006$) and HR was 1.45 in previous CHD (95% CI 1.90–2.33, $P = 0.1236$), and HR of TAS Q4 was reduced HR 0.64 (95% CI 0.35–1.17,

**Table 2** Hazard ratios of all cardiovascular events and all-cause deaths after multivariate adjustment: Impact of total activity score as a strong predictor

| Variants | All CV Events HR (95% CI) | *P*-value | All-Cause Deaths HR (95% CI) | *P*-VALUE |
|---|---|---|---|---|
| TAS | | | | |
| Q1 | 1.00 Reference | | 1.00 Reference | |
| Q2 | 0.74 (0.49–1.13) | 0.164 | 0.65 (0.33–1.29) | 0.223 |
| Q3 | 0.77 (0.51–1.17) | 0.226 | 0.81 (0.43–1.54) | 0.523 |
| Q4 | 0.62 (0.40–0.97) | 0.037 | 0.8 (0.41–1.56) | 0.513 |
| SBP | 1.01 (1.00–1.02) | 0.074 | 1.0 (0.99–1.02) | 0.912 |
| HbA1c | 1.17 (1.00–1.38) | 0.048 | 1.12 (0.87–1.43) | 0.382 |
| T-chol | 1.01 (1.00–1.01) | 0.056 | 1.0 (0.99–1.01) | 0.886 |
| HDL-C | 0.99 (0.98–1.01) | 0.333 | 1.0 (0.98–1.01) | 0.699 |
| TG | 1.0 (1.00–1.00) | 0.947 | 1.0 (1.00–1.00) | 0.999 |
| Age | 1.06 (1.03–1.10) | 0.0003 | 1.1 (1.05–1.16) | 0.0002 |
| Female | 0.51 (0.36–0.71) | <.0001 | 0.53 (0.32–0.89) | 0.016 |

CI, confidence interval; CV, cardiovascular; HbA1c, glycated hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; HR, hazard ratio; Q, quartile; SBP, systolic blood pressure; TAS, total activity score; T-chol, total cholesterol; TG, triglyceride.

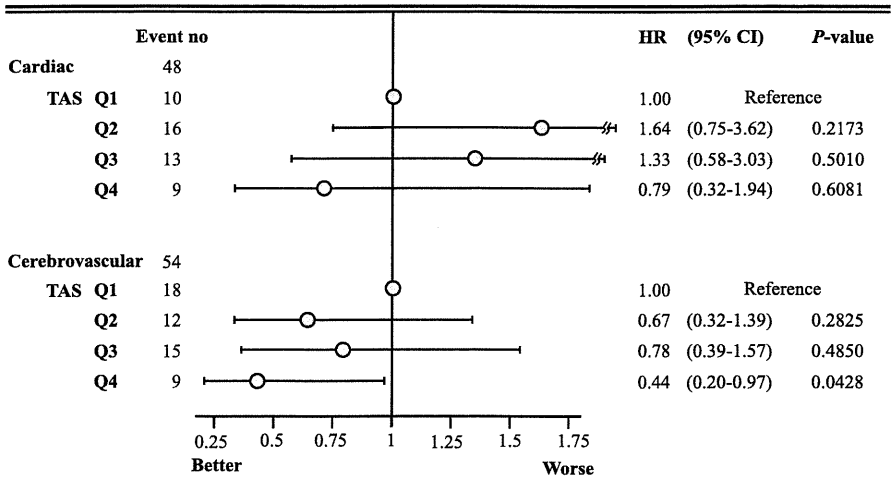



**Figure 2** Predictive power for cardiac events and cerebrovascular events according to total activity score (TAS) category. HR, hazard ratio; Q, quartile.

$P = 0.1447$). In addition, in case of adjustment using previous CVD or CHD, its presence of each previous vascular event showed statistical significance (HR 1.52, 95% CI 1.06–2.41, $P = 0.1006$). Unfortunately, HR of TAS Q4 was similarly reduced HR 0.65 (95% CI 0.35–1.18, $P = 0.1549$).

### *Significant correlation of TAS with cerebrovascular events compared with cardiac events*

The association of TAS with cerebrovascular events and cardiac events (AP, MI, coronary revascularization and heart failure) was evaluated. TAS was significantly associated with cerebrovascular disease including both fatal and non-fatal events, although there was no significant association between cardiac events and TAS (Fig. 2).

Next, we compared the predictive power of TAS according to sex and age (young-elderly aged 65–74 years and old-elderly patients aged ≥75 years; Table 3). First, with regard to sex, the predictive power of TAS for all CV events was stronger in women than in men. In addition, TAS in the young-elderly significantly predicted all CV events. In the old-elderly, a similar tendency was observed; however, the association did not reach statistical significance.

### *Comparison of predictive power of each component in TAS*

As described in the Methods section, TAS consists of three components: work activity, sports activity and non-sporting leisure-time activity. Subanalysis clearly

**Table 3** Predictive power of total activity score for all cardiovascular events and all-cause death according to sex and age

| | Male HR (95% CI) | *P*-value | Female HR (95% CI) | *P*-value |
|---|---|---|---|---|
| All CV events | | | | |
| TAS | | | | |
| Q1 | 1 Reference | | 1 Reference | |
| Q2 | 0.8 (0.46–1.39) | 0.429 | 0.84 (0.45–1.56) | 0.584 |
| Q3 | 0.95 (0.56–1.61) | 0.857 | 0.50 (0.25–1.03) | 0.062 |
| Q4 | 0.6 (0.34–1.08) | 0.087 | 0.47 (0.24–0.93) | 0.030 |
| All-cause deaths | | | | |
| Q1 | 1 Reference | | 1 Reference | |
| Q2 | 0.79 (0.33–1.91) | 0.606 | 0.73 (0.28–1.92) | 0.527 |
| Q3 | 1.08 (0.48–2.41) | 0.856 | 0.42 (0.13–1.35) | 0.148 |
| Q4 | 0.74 (0.31–1.78) | 0.496 | 0.60 (0.23–1.58) | 0.304 |
| | Young-Elderly HR (95% CI) | *P*-value | Old-Elderly HR (95% CI) | *P*-value |
| All CV events | | | | |
| TAS | | | | |
| Q1 | 1 Reference | | 1 Reference | |
| Q2 | 0.70 (0.41–1.21) | 0.204 | 1.07 (0.57–2.00) | 0.839 |
| Q3 | 0.81 (0.48–1.35) | 0.414 | 0.73 (0.36–1.49) | 0.387 |
| Q4 | 0.58 (0.34–0.98) | 0.042 | 0.54 (0.23–1.27) | 0.158 |
| All-cause deaths | | | | |
| Q1 | 1 Reference | | 1 Reference | |
| Q2 | 0.74 (0.31–1.76) | 0.498 | 0.8 (0.3–2.14) | 0.653 |
| Q3 | 0.74 (0.32–1.71) | 0.478 | 0.95 (0.35–2.55) | 0.916 |
| Q4 | 0.73 (0.33–1.63) | 0.448 | 0.68 (0.21–2.22) | 0.527 |

CI, confidence interval; CV, cardiovascular; HR, hazard ratio; Q, quartile; TAS, total activity score.

showed that the predictive power of "work activity" for all CV events was stronger than that of the other components (log–rank test; $P = 0.0003$) (Table 4). After adjustment, its power remained. The risk reduction of work activity was also significant, even in all-cause mortality (log–rank test; $P = 0.004$; data not shown). There was no statistical significance for sports activity. Regarding leisure-time activity, the risk reduction of it for all CV events in Q3 was strongest; however, statistical analysis did not show significance (log–rank test; $P = 0.11$).

### *Changes in each parameter during follow-up period*

To explore which parameter contributed to the risk reduction of all primary events, the changes in values (from baseline to the end of the follow-up period) of each parameter were calculated according to TAS grade (Table 5). Among the parameters, the differences in laboratory data, including lipid parameters and glucose metabolism, BP, physical measurements, cognitive function and depression scale, between TAS grades were not significant, suggesting that a higher level of physical activity itself was important in the risk reduction of events in elderly patients with T2DM.

## Discussion

Physical activity has been shown to reduce the risk of CV events; however, the biological mechanisms underlying this finding are still unclear. In the present study, the association of physical activity, as determined by TAS at baseline, with all CV events and all-cause mortality was evaluated in the J-EDIT study.

Higher TAS grade was significantly associated with a risk reduction in non-fatal all CV events; however, the association with all-cause mortality was not significant. In addition, among the three components of TAS, the predictive power of "work activity" was stronger than that of the other components – sports and leisure-time

**Table 4** Comparison of predictive power for all cardiovascular events according to each component of physical activity

| Component | Unadjusted | | | Adjusted* | | |
|---|---|---|---|---|---|---|
| | HR | 95% CI | *P*-value | HR | 95% CI | *P*-value |
| Work | | | | | | |
| None | 1 Reference | | | 1 Reference | | |
| Low | 0.57 | (0.4–0.83) | 0.0029 | 0.72 | (0.49–1.06) | 0.0972 |
| High | 0.53 | (0.37–0.76) | 0.0007 | 0.68 | (0.46–1.01) | 0.0538 |
| Sports | | | | | | |
| Low | 1 Reference | | | 1 Reference | | |
| High | 0.84 | (0.62–1.13) | 0.2455 | 0.8 | (0.59–1.08) | 0.1425 |
| Leisure-time | | | | | | |
| Q1 | 1 Reference | | | 1 Reference | | |
| Q2 | 0.73 | (0.49–1.09) | 0.1236 | 0.75 | (0.49–1.13) | 0.1633 |
| Q3 | 0.53 | (0.33–0.83) | 0.0062 | 0.6 | (0.37–0.95) | 0.0304 |
| Q4 | 0.75 | (0.5–1.11) | 0.1502 | 0.79 | (0.52–1.19) | 0.2534 |

*Simultaneously adjusted for age, sex, systolic blood pressure, glycated hemoglobin A1c, total cholesterol, triglyceride, and high-density lipoprotein cholesterol at baseline. CI, confidence interval; HR, hazard ratio.

**Table 5** Changes in each parameter throughout follow-up period according to total activity score category

| Variables | TAS category | | | | *P* for trend |
|---|---|---|---|---|---|
| | Quartile 1 | Quartile 2 | Quartile 3 | Quartile 4 | |
| FBS (mg/dL) | −21.2 (4.0) | −5.7 (4.4) | −11.7 (4.2) | −10.8 (3.8) | 0.0649 |
| HbA1c (%) | −0.6 (0.1) | −0.6 (0.1) | −0.5 (0.1) | −0.6 (0.1) | 0.8537 |
| T-chol (mg/dL) | −12.2 (2.5) | −16.7 (2.5) | −7.9 (2.4) | −11.3 (2.5) | 0.0979 |
| LDL-C (mg/dL) | −6.6 (2.2) | −11.3 (2.4) | −4.1 (2.3) | −7.1 (2.4) | 0.1744 |
| HDL-C (mg/dL) | −0.1 (2) | −2.4 (1) | −2.0 (1) | −1.8 (1) | 0.6101 |
| TG (mg/dL) | −15.5 (5.3) | −17.4 (7.9) | −5.2 (5) | −9.0 (4.7) | 0.4164 |
| SBP (mmHg) | −2.5 (1.1) | −1.7 (1.3) | −2.4 (1.3) | −2.2 (1.3) | 0.9673 |
| DBP (mmHg) | −4.0 (0.8) | −3.8 (0.8) | −2.6 (0.8) | −3.0 (0.7) | 0.5372 |
| PP (mmHg) | 1.6 (1.0) | 2.0 (1.1) | 0.0 (1.1) | 0.9 (1.1) | 0.573 |
| BMI (kg/m$^2$) | −0.2 (0.8) | −0.4 (0.2) | −0.6 (0.2) | −0.6 (0.2) | 0.9353 |
| Waist circumference (cm) | −0.8 (0.3) | −0.1 (0.4) | 0.6 (0.5) | −0.1 (0.3) | 0.1608 |
| Hip circumference (cm) | 0.5 (0.4) | 0.0 (0.4) | 0.4 (0.4) | −0.1 (0.4) | 0.6398 |
| W/H ratio | 0.0 (0.0) | 0.6 (0.5) | 0.5 (0.5) | 0.5 (0.5) | 0.7671 |
| MMSE | −0.3 (0.1) | −0.4 (0.1) | −0.4 (0.1) | −0.4 (0.1) | 0.8441 |
| GDS15 | 0.0 (0.1) | 0.1 (0.1) | 0.0 (0.1) | 0.3 (0.1) | 0.1087 |

BMI, body mass index; DBP, diastolic blood pressure; FBS, fasting blood glucose; GDS, Geriatric Depression Scale; HbA1c, glycated hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MMSE, Mini-Mental State Examination; PP, pulse pressure; SBP, systolic blood pressure; sCr, serum creatinine; SS, sports score; TAS, total activity score; T-chol, total cholesterol; TG, triglyceride; W/H ratio, waist-to-hip circumference ratio; WAS, work activity score.

activity. There was no significant difference in the change in almost all parameters among TAS grades throughout the follow-up period in the present trial. Therefore, we emphasize the following conclusion: (i) our data provide evidence that lower physical activity is a strong and independent predictor of CV events in the elderly with T2DM beyond traditional risk factors; (ii) in addition to routine strict management of laboratory data in clinical practice, engagement with patients to enhance and/or maintain physical activity in their lifestyle is also important. In fact, the elderly have retired from their routine jobs. The results of the present study show that they should do at least slight work routinely in their daily life, such as cooking or gardening. It might be meaningful for them to carry out some activity and continue it by themselves.

Physical activity is a well-established approach to reducing the risk of many chronic diseases. Most studies have shown a significant relative reduction in the incidence of CV events in physically active participants; however, the range of benefit showed considerable variation. For example, Myers *et al.* reported a marked reduction in all-cause mortality of 72% between active and inactive male participants during 6 years of follow up,[21] whereas Lee *et al.* found a risk reduction of just 13%.[22] It is clear that the risk reduction might vary depending on adjustment for important covariables, such as BP and profiles of lipid and glucose metabolism. With regard to adjustment for several relevant risk factors, a meta-analysis handling a total of 33 studies with 883 372 participants (follow-up period from 4 years to over 20 years) clearly showed an important correlation of higher physical activity with a risk reduction in CV mortality of 35% (95% CI 30–40%).[23] In addition, all-cause mortality was also reduced by 33% (95% CI 28–37%). This systematic review by meta-analysis emphasized that physical activity was associated with a marked decrease in CV and all-cause mortality in both sexes, even after adjusting for other relevant risk factors. In the present study, there was a good correlation between TAS and all CV events. However, after adjustment of previous atherosclerotic diseases, its presence of previous CVD or CHD showed a significant association with CV events during the follow-up period. Consequently, the predictive power of TAS against all CV events was slightly decreased. These observations might suggest a high risk of recurrence of CV events in T2DM patients beyond TAS grade at the baseline. Therefore, further subanalysis to simply evaluate the predictive power of TAS as primary prevention against CV events using elderly patients without both previous CVD and CHD is required. In addition, regarding all-cause mortality, TAS tended to show an association with it; however, no statistical significance was reached. One of the hypotheses to explain the relationship and discrepancy is that the sample size was relatively small and non-fatal CV events rather than fatal events might be frequently observed in all participants with T2DM at the baseline.

Next, we focused on cognitive function and depressive mood. The presence of geriatric syndrome including cognitive dysfunction has been shown to be a major factor in decline in physical activity level in the older elderly. Besides traditional risk factors, it has been clearly shown that "depressive mood" readily causes a decline in physical activity, leading to increased risk of CV disease.[24] In addition, patients with depression had a worse prognosis than those without depression after a myocardial infarction.[25,26] Prospective studies have shown that depressed people develop a more sedentary lifestyle and become less physically active.[27,28] In fact, the GDS score was higher in the lower TAS group in the present study as well. Therefore, this evidence that the importance of physical activity in the risk reduction of CV events is also associated with depressive mood is consistent with previous reports. However, the average GDS score was not so high (range 3–5 points). In addition, depressive score did not decrease, even in the lowest TAS group (Q1), throughout the follow-up period. In subanalysis, the inverse correlation between GDS and TAS was more clearly found in young-elderly patients, compared with old-elderly patients. In view of these results, especially in young-elderly patients, detailed assessment of the patient's mentality, including depressive mood, should be considered more aggressively and routinely.

The predictive power of TAS was compared between CHD and CVD. The relative risk of CVD decreased with increasing TAS, with statistical significance; however, no significance was found for CHD. In fact, we found some evidence regarding this discrepancy. Although the incidence of CHD among physically active elderly men in the Honolulu Heart Program study was less than half that in more sedentary men,[29] no clear association was observed in the Established Populations for Epidemiologic Studies of the Elderly study.[30] Compared with CHD, the correlation of physical activity with stroke has not been extensively examined for any age group.[31] However, a meta-analysis handling five epidemiological case–control studies has reported that all studies had consistent evidence showing a large advantage of higher physical activity in reducing the risk of stroke.[32]

As another interest in our data, "work activity" was the most potent predictor of first events among the three components. This suggests that, even if the patient's age is over 65 years, the fact that they are motivated to routinely try to do at least any slight work might enhance their total physical activity.

The present analysis was based on the physical activity score measured once at enrolment in the J-EDIT study. However, during the follow-up period of this trial, some patients showed a gradual decline in TAS. It is notable that new development or progression of diabetic complications, such as neuropathy and retinopathy, readily leads to a decline in physical activity. Therefore, further investigation to evaluate which factor mainly caused the decline in TAS throughout the follow-up period is necessary. This could provide supportive information on the cause–effect relationship of the associations found in this trial.

In addition, the current associations might not be extended to all populations, because the enrolled participants in the present trial were patients with T2DM. Whether the observed associations can be generalized to populations of much older ages and populations without T2DM is unknown.

This prospective follow-up study confirmed that lower physical activity is a strong independent predictor

of onset of CV events, even in Japanese elderly with T2DM. The data in the present study suggest the potential of activity to enhance overall health and well-being with aging. Ultimately, the key is to aggressively translate these findings into public health efforts.

The majority of elderly patients still have a primarily sedentary life. Numerous studies have already addressed the importance of physical activity in health management; however, unfortunately, medical staff might not have been educated about how to promote and augment the level of physical activity in elderly patients. Therefore, as well as strict management of each atherosclerotic risk factor, we should aggressively assess physical activity (especially working) and encourage elderly patients to increase or maintain their level of physical activity.

## Acknowledgments

We thank all patients, physicians, and staff who took part in the J-EDIT study.

The registration number for this clinical trial was UMIN000000890. This study was financially supported by Research Grants for Longevity Sciences from the Ministry of Health and Labour, and Welfare (H12-Choju-016, H15-Chojyu-016, H17-Choju-Ordinal-013) and the Japan Foundation for Aging and Health.

## Conflict of interest

There is no conflict of interest. The J-EDIT Study Group has not cleared any potential conflicts.

## References

1 Berlin JA. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol* 1990; **132**: 612–628.
2 Powell KE, Thompson PD, Caspersen CJ, Kendrick JS. Physical activity and the incidence of coronary heart disease. *Annu Rev Public Health* 1987; **8**: 253–287.
3 Abbott RD, Rodriguez BL, Burchfiel CM, Curb JD. Physical activity in older middle-aged men and reduced risk of stroke: the Honolulu Heart Program. *Am J Epidemiol* 1994; **139**: 881–893.
4 Blair SN, Kohl HW III, Paffenbarger RS Jr, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality: a prospective study of healthy men and women. *JAMA* 1989; **262**: 2395–2401.
5 Manson JE, Hu FB, Rich-Edwards JW. A prospective study of walking as compared with vigorous exercise in the prevention of coronary heart disease in women. *N Engl J Med* 1999; **341**: 650–658.
6 Lee IM, Sesso HD, Paffenbarger RS Jr. Physical activity and coronary heart disease risk in men. Does the duration of exercise episodes predict risk? *Circulation* 2000; **102**: 981–986.
7 WHO Study Group on Epidemiology and Prevention of Cardiovascular Diseases in the Elderly. *Epidemiology and Prevention of Cardiovascular Diseases in Elderly People: Report of A WHO Study Group*. Geneva: World Health Organization, 1995; *WHO Technical Report Series* No. 853.
8 US Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
9 Pate RR, Pratt M, Blair SN *et al.* Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995; **273**: 402–407.
10 Inoue M, Iso H, Yamamoto S *et al.* Japan Public Health Center-Based Prospective Study Group. Daily total physical activity level and premature death in men and women: results from a large-scale population-based cohort study in Japan (JPHC study). *Ann Epidemiol* 2008; **18**: 522–530.
11 Menotti A, Blackburn H, Kromhout D, Nissinen A, Adachi H, Lanti M. Cardiovascular risk factors as determinants of 25-year all-cause mortality in the seven countries study. *Eur J Epidemiol* 2001; **17**: 337–346.
12 Fujita K, Takahashi H, Miura C *et al.* Walking and mortality in Japan: the Miyagi Cohort Study. *J Epidemiol* 2004; **14** (Suppl 1): S26–S32.
13 Sherman SE, D'Agostino RB, Cobb JL, Kannel WB. Does exercise reduce mortality rates in the elderly? Experience from the Framingham Heart Study. *Am Heart J* 1994; **128**: 965–972.
14 Hakim AA, Petrovitch H, Burchfiel CM *et al.* Effects of walking on mortality among nonsmoking retired men. *N Engl J Med* 1998; **338**: 94–99.
15 Wannamethee SG, Shaper AG, Walker M. Changes in physical activity, mortality, and incidence of coronary heart disease in older men. *Lancet* 1998; **351**: 1603–1608.
16 Manini TM, Everhart JE, Patel KV *et al.* Daily activity energy expenditure and mortality among older adults. *JAMA* 2006; **296**: 171–179.
17 Bembom O, van der Laan M, Haight T, Tager I. Leisure-time physical activity and all-cause mortality in an elderly cohort. *Epidemiology* 2009; **20**: 424–430.
18 Baecke JA, Burema J, Frijters JE. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *Am J Clin Nutr* 1982; **36**: 936–942.
19 Pols MA, Peeters PH, Bueno-De-Mesquita HB *et al.* Validity and repeatability of a modified Baecke questionnaire on physical activity. *Int J Epidemiol* 1995; **24**: 381–388.
20 Koyano W, Shibata H, Nakazato K, Haga H, Suyama Y. Measurement of competence and instrumental activities of daily living. *Arch Gerontol Geriatr* 1991; **13**: 103–116.
21 Myers J, Kaykha A, George S *et al.* Fitness versus physical activity patterns in predicting mortality in men. *Am J Med* 2004; **117**: 912–918.
22 Lee IM, Hsieh CC, Paffenbarger RS Jr. Exercise intensity and longevity in men. The Harvard Alumni Health Study. *JAMA* 1995; **273**: 1179–1184.
23 Nocon M, Hiemann T, Müller-Riemenschneider F, Thalau F, Roll S, Willich SN. Association of physical activity with all-cause and cardiovascular mortality: a systematic review and meta-analysis. *Eur J Cardiovasc Prev Rehabil* 2008; **15**: 239–246.
24 Hemingway H, Marmot M. Evidence based cardiology: psychosocial factors in the aetiology and prognosis of coronary heart disease. Systematic review of prospective cohort studies. *BMJ* 1999; **318**: 1460–1467.
25 Van der Kooy K, van Hout H, Marwijk H, Marten H, Stehouwer C, Beekman A. Depression and the risk for cardiovascular diseases: systematic review and meta analysis. *Int J Geriatr Psychiatry* 2007; **22**: 613–626.

26 Wulsin LR, Singal BM. Do depressive symptoms increase the risk for the onset of coronary disease? A systematic quantitative review. *Psychosom Med* 2003; **65**: 201–210.
27 Bonnet F, Irving K, Terra JL, Nony P, Berthezène F, Moulin P. Anxiety and depression are associated with unhealthy lifestyle in patients at risk of cardiovascular disease. *Atherosclerosis* 2005; **178**: 339–344.
28 van Gool CH, Kempen GI, Penninx BW, Deeg DJ, Beekman AT, van Eijk JT. Relationship between changes in depressive symptoms and unhealthy lifestyles in late middle aged and older persons: results from the Longitudinal Aging Study Amsterdam. *Age Ageing* 2003; **32**: 81–87.
29 Donahue RP, Abbott RD, Reed DM, Yano K. Physical activity and coronary heart disease in middle-aged and elderly men: the Honolulu Heart Program. *Am J Public Health* 1988; **78**: 683–685.
30 Simonsick EM, Lafferty ME, Phillips CL *et al.* Risk due to inactivity in physically capable older adults. *Am J Public Health* 1993; **83**: 1443–1450.
31 Bronner LL, Kanter DS, Manson JE. Primary prevention of stroke. *N Engl J Med* 1995; **333**: 1392–1400.
32 Lee CD, Folsom AR, Blair SN. Physical activity and stroke risk: a meta-analysis. *Stroke* 2003; **34**: 2475–2481.