連載

健康の社会的決定要因(14)
「医療アクセスと健康格差」

浜松医科大学医学部健康社会医学講座　村田千代栄
日本福祉大学健康社会研究センター　近藤　克則

1. はじめに

喫煙や栄養バランスの偏った食事，運動不足など不健康な健康習慣に加え，個人の所得，教育程度，職業など社会経済的地位が健康と関連していることは多くの研究により示されている。たとえば，社会経済的地位が低い者には抑うつが多く[1,2]，要介護状態に陥りやすい[3]だけでなく，死亡率も高い[4]。世界保健機構（WHO）の「健康の社会的決定要因に関する専門委員会（the Commission on Social Determinants of Health）の最終報告書[5]によると，健康の格差には，個人の生活習慣だけでなく，居住環境，労働環境など周りの環境が影響しており，その中には医療制度のあり方も含まれる。

医療制度のあり方を論じるに当たり，医療アクセスという言葉がしばしば使われる。医療アクセスの問題は，2つの軸から議論されることが多い。一つは医療機関への距離や交通機関の有無などの物理的な条件によるアクセスの問題であり，もう一つは，受診や治療にかかる費用など社会経済的あるいは医療保障の条件によるアクセスの問題である。医療へのアクセスの公平性（equity）は，医療サービスが誰にでも利用可能であることが前提にあり，必要とする人々に医療サービスが活用されることで成立する。受診抑制とは，必要にも関わらず何らかの原因で受診を控えることを意味し，医療へのアクセスを測定する際の重要な指標となっている。日本は国民皆保険制度のもと，医療へのアクセスが広く保障されてきたと考えられていたが，近年，低所得者で高所得者の2倍以上の受診抑制がみられるなど，経済力による格差が指摘されるようになっている[6]。そこで本稿では，主に医療へのアクセスに社会経済的地位による格差がどの程度見られるのか，内外の研究を紹介しながら検討していく。

2. 医療へのアクセスと社会経済的地位

多くの研究により所得や教育年数などの社会経済的地位が低いほど，受診抑制が高率でみられ[5]，その主な理由として窓口での費用負担の問題が指摘されている。受診における格差は，その国の医療保障制度と関連しており，受診時の費用負担の大きさは受診抑制の大きな決定要因となっている[7]。保険に加入していない者と保険加入者とで，過去2ヶ月間の受診状況を比較した米国の研究によると，不慮の外傷では，無保険者が治療を受けるオッズ比が0.47と保険加入者の半分以下であり，慢性疾患でも，治療オッズ比は無保険者で0.45と明らかな受診抑制がみられた。さらに，無保険者では，約7ヶ月後の健康状態も悪かった[8]。米国とカナダの比較研究[9]によれば，両国とも所得が低かったり，学歴が短いほど，必要な治療を受けていない者やかかりつけ医のいない者の割合が多かった。しかし，国民皆保険制度であるカナダでは，そうでない米国にくらべ，所得による医療アクセスの格差が小さいこともわかった。

無保険者だけでなく，十分な保険に入っていない場合にも受診抑制が起こる。米国では保険の種類によってカバーされる内容が異なるため，保険でカバーされる範囲が少ないunder-insured（低水準被保険者）が存在する。心筋梗塞患者2498人を対象に，費用を理由に受診を控えた群（18.1%）と，それ以外の群とで比較した研究がある[10]。何らかの保険に加入していても，費用を理由に受診を控えた者（受診抑制あり群）は68.9%に上り，その後一年間に心疾患が原因で再入院した割合は，受診抑制なし群の17.7%に対し，あり群で25.7%と，調整済みリスク比でも1.3倍再入院をしやすいという結果であった。つまり，医療保険に加入していても，医療保障の水準が低いと，受診抑制が起き，健康状態が悪化して再入院が増えることを示唆している。また，自己負担の種類と程度が異なる15種類の保険の1つを無作為に割り当て，医療サービスの利用や健康水準を調べた米国のランド調査研究によると，自己負担が増えるにつれ，重要な薬をはじめとする医療の利用が減少し，それに伴い健康状態も悪化したので

ある[11]。

受診抑制がおこる理由として，医療保険の種類やその有無のほかに，受診の際に支払う自己負担額もあげられる。2007年7月に国立社会保障・人口問題研究所により実施された『社会保障実態調査』によると，過去1年間に誰も医療機関にかからなかった世帯のうち，「健康ではなかったが，受診できなかった」者がいた世帯は17%であり，その理由として最も多かったのが「自己負担割合が高いなど経済的理由」（38.4%）であった[12]。また，日本医療政策機構による『日本の医療に関する2008年世論調査』によると，費用を理由に過去12カ月以内に「具合が悪いところがあるのに医療機関に行かなかったことがある」者の割合が，高所得者の18%に対し，低所得者では39%と約2倍であった。同様の理由で「薬を処方してもらわなかったことがある」者は，高所得者の2%に対し，低所得者では16%と8倍であった[13]。

日本の代表サンプル（20歳～89歳）を用いた研究（JGSS-2008）でも，所得が低い者ほど受診抑制が高率でみられたことを報告している[14]。厚生労働省が2001年から行っている『21世紀出生児縦断調査』の0-4歳児約3万3000人のパネル調査（同じ対象者を繰り返し調査する方法）データによれば，貧困経験が多い子どもほど入院を伴うような重大な疾病が多く，受診抑制は見られない半面，通院経験は逆に少なく，疾病の早期における受診抑制があることが推測された[15]。

自己負担額の増加も受診抑制と関連している。馬場園らは，日本の健康保険加入者において，医療費の自己負担が増えると所得が低い階層で受診抑制が生じることを報告している[16]。また，この研究では，自己負担率が20%から30%になった結果，合併症のない糖尿病患者において外来受診の減少がみられ，初期症状のない疾患で受診抑制が起こりやすいことが示唆された。フランス，ドイツ，スペインの3カ国を比較した研究では，患者の自己負担額が増えた結果，特に低所得者など社会階層が低い人々において外来受診が減少したことを報告している[17]。同様な結果は，韓国や台湾における研究でも報告されている[18,19]。日本の要介護認定を受けていない一般高齢者を対象に，受診抑制の理由を検討した2006年の調査（N＝15302）でも同様であり，自己負担率の高い70歳未満（調査当時の自己負担率は70歳未満で3割，70歳以上で1割）で，費用を理由とした受診抑制が多かった（65～69歳で35.8%，70歳以上で20.1%）[20]。

別の要因として，物理的アクセスの問題もある。前述の日本の高齢者の研究[20]では，必要な受診を控えた理由として「近くにない」（65～69歳で9.0%，70歳以上で15.4%）や「交通手段がない」（65～69歳で4.7%，70歳以上で13.2%）と，高齢になるほど物理的なアクセスが問題となっていた。米国でも，医療機関への距離は，特に高齢者において受診抑制の原因となっていることを報告している[7]。英国では，公衆衛生サービスへの物理的アクセスが良いほど住民の健康状態がよいことがわかっており[21]，ナイジェリアでも，同様の関連がみられた[22]。

上述の物理的・社会経済的アクセスの差は，受ける医療の質にも影響している。米国の代表サンプルを用いた研究では，人口の少ない地域（農村など）[7]や，低所得者[23]で急性心筋梗塞で入院した患者の死亡率が高いことが示されている。その理由として，医療従事者の不足や医療機関が近くにないこと[7]や，費用[23]による受診抑制があげられた。ヨーロッパ諸国でも，受ける医療サービスの種類に格差がみられ，一定の基準を満たす26論文を集めたシステマティック・レビュー[24]によれば，プライマリケアにおいては，ある程度医療サービス利用の公平性が保たれているが，病院における専門医療では，低所得者で利用が少ない実態がみられた。訪問看護を受けた後に死亡した日本の高齢者1305人を対象にした研究でも，経済的に余裕のない者ほど自宅で亡くなる率は低く，担当の訪問看護師が評価した「死および死に至る過程の質」も低い者が多かった[25]。

3. 格差が生まれる背景

格差が生まれる背景には，社会経済的・物理的アクセスに加え，心理的要因も関わっている。抑うつなど精神的健康度が低い者ほど，不健康な行動が見られることが報告されている[26]が，米国の医療保険受給状況調査（MEPS）を用いた研究では，精神的苦痛（Psychological Distress）（SF-12を用いた）が，各種健診の受診率の低さと関連していた[27]。日本の高齢者の研究でも，抑うつが健診受診率の低さと関連しており[28]，別の研究でも，将来に楽しみがない者はある者よりも，健診受診率が低いことが示されている[29]。

コミュニケーションやヘルスリテラシーの問題もある。ヘルスリテラシーとは，健康に関わる問題について，必要な情報を収集し，理解し，利用する能力のことである[30]。米国の研究では，社会経済的地位の低い層で医療への不信感が強いこと[31]や，医師とのコミュニケーションが不良であり，受ける医療の質も低いことを報告している[32]。日米両国とも，待ち時間や距離よりも，「医師がわかりやすく説明

してくれる」,「自分の話を聞いてくれる」といったコミュニケーションの質が，医療満足度とより強く関連していることが報告されている[32,33]。医療全体への信頼感が低いと受診抑制につながるというスウェーデンの報告もある[34]。日本でも，社会経済的地位の低い者は，実際の健康状態に関わらず，医療を受けられないのではないかという不安が高く，必要な治療を控える傾向があった[35]。複数の質的研究を検討したメタ研究でも，健康関連の問題について分析し理解する能力，つまりヘルスリテラシーが低いことは，患者と医療従事者とのコミュニケーションの質の悪さにつながっていた[30]。

米国厚生省（HHS）の下部組織，Agency for Healthcare Research and Quality（AHRQ：医療分野の研究と質向上を支援する部門）は，社会経済的地位が低いほど糖尿病の治療を受けず，糖尿病やその合併症により入院する確率が高いことを報告している[7]が，糖尿病は高血圧と同様，初期症状がないため，受診抑制が起こりやすい。同報告書では，社会経済的地位が低いほど，健診受診や予防接種などの予防行動をとる割合が低いことも示されており，これにもヘルスリテラシーが関連している可能性がある。同じく米国の癌検診でも，便潜血検査や大腸ファイバー検査を受けた割合は低所得層で高所得層よりも低く[36]，日本でも，高齢者の健診未受診は，社会経済的地位の低さと関連していた[28]。

4. 医療アクセスの格差への対策

以上述べてきたように，医療費の自己負担が増えると，不要な受診だけでなく必要な医療も抑制されること，またその傾向は所得が低い人々により顕著であることが確認されている。WHOは「すべての人に健康を（Health for All）」のスローガンのもと，「政府が主導して，医療制度の財政や皆保険制度の創設，自己負担を最小限にとどめるよう努力する」よう求めている[5]。内閣府の政策効果分析レポートでは，60歳代前半で所得が低い国民健康保険加入者では，受診抑制が相対的に高率で見られることが報告され，就業や所得状態に応じた医療保険に関わる負担の軽減など，弾力的な制度運用を行う配慮が必要であるとしている[37]。ヨーロッパ[11]およびOECD加盟諸国[38]の医療制度改革の経験をまとめた報告書によれば，自己負担が増えると，不要な医療が減る半面，必要な医療も減る。しかも，低所得者ほど不健康であり，医療の必要性が高いにもかかわらず，必要な医療から排除されやすくなることが指摘されている。医療アクセスによる健康格差の是正のためには，低所得者層も安心して医療にかかれる医療保障制度が重要である。

それに加え，医療へのアクセスには，自己負担額だけでなく，無保険者の問題も含めた議論が必要である。皆保険制度の日本でも，国民健康保険加入世帯の18.6％が保険料を滞納している[39]。特別の事情がなく1年以上国民健康保険料を滞納していると保険証がとりあげられ，「資格証」が交付されるが，その「資格証」交付世帯が34万世帯にのぼっている。このような世帯では，受診時にいったん医療費を全額支払う必要があるため，受診抑制が一般世帯の32倍から200倍も起こりやすい[39]。医療機関にかからずに手遅れで亡くなった例も18都道府県で27人いることが報告されている[39]。米国では，低所得家庭の子どもを対象にした医療保険システム［State Children's Health Insurance Program（SCHIP）］の創設により，子どもにおいて，医療アクセスにおける格差が縮小したことが示されている[40]。日本でも，親が国民健康保険の保険料を滞納したことにより無保険状態になった中学生以下の子どもに対し，短期保険証の交付を取り決めた改正国民健康法が成立し，2009年4月から施行された。

医療制度の見直しによるこのような格差への対処は重要である。しかし，この問題に対処するためには，制度の見直しだけでは不十分である。格差の背景として，医療に対する不信やコミュニケーションの問題も指摘されているからである[37]。また，低所得者ほど健診を受けない[28]理由として，制度や社会経済的・物理的アクセスの問題だけでなく，心理的要因もある[37]。地域でできる方策として，英国での取り組みが参考になるかもしれない。英国政府の委託により，2010年8月からリバプールで「Healthy Homes」という事業が始まった。「より健康的な家で，より健康的な生活を」をキャッチフレーズに，貧困地域（このような地域には移民も多い）を40ヶ所指定し，1件ずつ訪問し，立ち入り検査を行った。家屋に健康への問題がある場合は，家主に改善命令が出される。この立ち入りの際に，健康上の問題を抱えている人に対する医療サービスの紹介も行われ，言葉の問題や健康意識の低さにより，症状が重くなるまで受診しない移民や貧困層の早期受診にも一役買ったのである[41]。また，妊婦健診の未受診の背景には，経済的理由があげられる[42]が，乳児死亡率が全国平均の1.3倍というロンドンの最貧困地区で，地元の助産師が大学や病院に呼びかけ，2008年に対策チームを結成した。地域の若い母親たちに呼びかけ，「Bump Buddies」というボランティアグループを発足させたのである。同じ民族や同じ肌の色の若いメンバーが町の中で妊婦を見かけたら話し

かけ，医療サービスにつなげた結果，妊婦健診の未受診率が半減した[41]。これは，ボランティアの活用によって，様々な理由で受診を控えていた人々を医療サービスや専門機関につなぐことができた好例である。日本では，伝統的に社会福祉協議会や自治体，地域住民などのパートナーシップによる，子育て支援ボランティアや高齢者の見守り活動など，様々な地域福祉活動が行われてきたが，地域の力を生かしたこのような活動は，今後ますます重要になるであろう。

謝辞

本研究は，文部科学省の助成（課題番号19530490；21530585）を受け，私立大学戦略的研究基盤形成支援事業の助成を受けたAGES（愛知老年学的評価研究）プロジェクトの一環として実施された。

文　献

1) Weissman MM, Bland RC, Canino GJ, et al. Cross-national epidemiology of major depression and bipolar disorder. JAMA 1996; 276(4): 293-299.
2) Lorant V, Deliège D, Eaton W, et al. Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol 2003; 157(2): 98-112.
3) Beydoun MA, Popkin BM. The impact of socio-economic factors on functional status decline among community-dwelling older adults in China. Soc Sci Med 2005; 60(9): 2045-2057.
4) Kagamimori S, Gaina A, Nasermoaddeli A. Socioeconomic status and health in the Japanese population. Soc Sci Med 2009; 68(12): 2152-2160.
5) Commission on Social Determinants of Health (CSDH). Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health. Final Report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008; 94-106.
6) 日本医療政策機構．日本の医療に関する2007年世論調査．2007．http://www.hgpi.org/report_events.html?article＝45（2011年5月8日アクセス可能）
7) Agency for Healthcare Research and Quality. National Healthcare Disparities Reports. Rockville: Agency for Healthcare Research and Quality, 2010. http://www.ahrq.gov/qual/qrdr09.htm（2011年1月13日アクセス可能）
8) Hadley J. Insurance coverage, medical care use, and short-term health changes following an unintentional injury or the onset of a chronic condition. JAMA 2007; 297(10): 1073-1084.
9) Lasser KE, Himmelstein DU, Woolhandler S. Access to care, health status, and health disparities in the United States and Canada: results of a cross-national population-based survey. Am J Public Health 2006; 96(7): 1300-1307.
10) Rahimi AR, Spertus JA, Reid KJ, et al. Financial barriers to health care and outcomes after acute myocardial infarction. JAMA 2007; 297(10): 1063-1072.
11) ロビンソンR．医療における自己負担．Mossialos E, Dixon A, Figueras J, et al. eds. 医療財源論．ヨーロッパの選択［Funding Health Care: Options for Europe］（一圓光彌，監訳）東京：光生館，2004; 189-214.
12) 国立社会保障・人口問題研究所．社会保障実態調査．2007年7月．http://www.ipss.go.jp/ss-seikatsu/j/jittai2007/janda/jittai2007.asp（2011年5月8日アクセス可能）
13) 日本医療政策機構．日本の医療に関する2008年世論調査．2008．http://www.hgpi.org/report_events.html?article＝42（2011年5月8日アクセス可能）
14) 埴淵知哉．医療と健康の格差：JGSS-2008に基づく医療アクセスの分析．日本版総合的社会調査共同研究拠点 研究論文集［10］JGSS Research Series No. 7. 2010; 10: 99-110.
15) 阿部　彩．子どもの健康と貧困の経験．平成19年度厚労科学研究費補助金（統計情報総合研究事業）総括研究報告書　パネル調査(縦断調査)に関する総合的分析システムの開発研究（主任研究者　金子隆一）2008; 205-216.
16) Babazono A, Miyazaki M, Imatoh T, et al. Effects of the increase in co-payments from 20 to 30 percent on the compliance rate of patients with hypertension or diabetes mellitus in the employed health insurance system. Int J Technol Assessment Health Care 2005; 21(2): 228-233.
17) Lostao L, Regidor E, Geyer S, et al. Patient cost sharing and social inequalities in access to health care in three western European countries. Soc Sci Med 2007; 65(2): 367-376.
18) Kim J, Ko S, Yang B. The effects of patient cost sharing on ambulatory utilization in South Korea. Health Policy 2005; 72(3): 293-300.
19) Huang JH, Tung CM. The effects of outpatient co-payment policy on healthcare usage by the elderly in Taiwan. Arch Gerontol Geriatr 2006; 43(1): 101-116.
20) Murata C, Yamada T, Chen CC, et al. Barriers to health care among the elderly in Japan. Int J Environ Res Public Health 2010; 7(4): 1330-1341.
21) Barnett S, Roderick P, Martin D, et al. A multilevel analysis of the effects of rurality and social deprivation on premature limiting long term illness. J Epidemiol Commun Health 2001; 55(1): 44-51.
22) Onwujekwe O. Inequities in healthcare seeking in the treatment of communicable endemic diseases in Southeast Nigeria. Soc Sci Med 2005; 61(2): 455-463.
23) Shi L, Stevens GD. Vulnerability and unmet health care needs. The influence of multiple risk factors. J Gen Internal Med 2005; 20(2): 148-154.
24) Hanratty B, Zhang T, Whitehead M. How close have universal health systems come to achieving equity in use of curative services? A systematic review. Int J Health

Serv 2007; 37(1): 89-109.
25) 杉本浩章，近藤克則，樋口京子．　世帯の経済水準による終末期ケア格差：在宅療養高齢者を対象とした全国調査から．社会福祉学（印刷中）
26) Lett HS, Blumenthal JA, Babyak MA, et al. Depression as a risk factor for coronary artery disease: evidence, mechanisms, and treatment. Psychosom Med 2004; 66(3): 305-315.
27) Thorpe JM, Kalinowski CT, Patterson ME, et al. Psychological distress as a barrier to preventive care in community-dwelling elderly in the United States. Med Care 2006; 44(2): 187-191.
28) 平松　誠，近藤克則，平井　寛．介護予防施策の対象者が健診を受診しない背景要因：社会経済的因子に着目して．厚生の指標 2009; 56(3): 1-8.
29) 近藤克則，花岡智恵，平井　寛，他．高齢者の健診受診と「将来における楽しみ」，所得との関連：AGESプロジェクト．第69回日本公衆衛生学会総会抄録集．2010; 395.
30) Edwards M, Davies M, Edwards A. What are the external influences on information exchange and shared decision-making in healthcare consultations: a meta-synthesis of the literature. Patient Educ Couns 2009; 75(1): 37-52.
31) Doescher MP, Saver BG, Franks P, et al. Racial and ethnic disparities in perceptions of physician style and trust. Arch Fam Med 2000; 9(10): 1156-1163.
32) Saha S, Arbelaez JJ, Cooper LA. Patient-physician relationships and racial disparities in the quality of health care. Am J Public Health 2003; 93(10): 1713-1719.
33) 前田　泉，徳田茂二．患者満足度：コミュニケーションと受療行動のダイナミズム．東京：日本評論社，2003; 65-76.
34) Mohseni M, Lindstrom M. Social capital, trust in the health-care system and self-rated health: the role of access to health care in a population-based study. Soc Sci Med 2007; 64(7): 1373-1383.
35) 村田千代栄．医療不安と社会経済的地位の関連：JGSS-2008に基づく分析．日本版General Social Surveys研究論文集 2010; 10: 111-122.
36) Centers for Disease Control and Prevention. CDC health disparities and inequalities report -United States, 2011. MMWR Surveill Summ 2011; 60 Suppl: 1-2.
37) 内閣府政策統括官室．政策効果分析レポートNo.20 医療保険制度と年齢階層別にみた受診行動．2006. http://www5.cao.go.jp/keizai3/seisakukoka.html（2011年5月8日アクセス可能）
38) The OECD Health project. 世界の医療制度改革：質の良い効率的な医療システムに向けて［The　OECD Health Project: Towards High-Performing Health Systems］（阿万哲也，訳）東京：明石書店，2005.
39) 芝田英昭．国民健康保険滞納者の健康破壊は皆保険体制崩壊の始まり．公衆衛生 2008; 72(9): 708-716.
40) Shone LP, Dick AW, Klein JD, et al. Reduction in racial and ethnic disparities after enrollment in the State Children's Health Insurance Program. Pediatrics 2005; 115(6): e697-e705.
41) 岩永直子，近藤克則．健康の社会的決定要因への介入　イギリスNHSの現場に見る健康格差対策．病院 2011; 70(1): 19-23.
42) 水主川純，定月みゆき，箕浦茂樹，他．当科における妊婦健康診査未受診妊婦の検討．日本周産期・新生児医学会雑誌 2009; 45(1): 32-36.

連載

健康の社会的決定要因(15)
最終回　WHOの健康格差対策

日本福祉大学　近藤　克則

本連載では，表1に掲げた多くの疾患・健康問題を取り上げ，「健康の社会的決定要因（social determinants of health, SDH）」がいかに重要なのかを，主に海外における研究成果を元に述べてきた。日本は，国民皆保険・皆年金を半世紀前に実現した格差の小さい国と思われてきたためか，引用したくとも社会階層と（不）健康との関連についての研究が今まであまりなされてこなかったからである。しかし，そのことは日本には健康格差（社会階層が低い人たちに不健康な人が多い）問題がないことを意味しない。

確かに日本は，1980年初期まで（所得分配の不平等度の大きさを表す）ジニ係数でみると格差が縮小する傾向にあったが，その後は格差の拡大に転じ，今ではOECD加盟諸国の中で，ジニ係数（＝不平等度）が大きなグループの国となった。貧困層の割合（中央値の50％未満）も，2000年代中頃にはOECD加盟30ヵ国の平均10.6％に対し14.9％とメキシコ，トルコ，アメリカに次いで4番目に多い国となっている[1]。20代の若年層の失業率は10％に迫り，雇用されている者においても派遣労働者など不安定な非正規雇用が3人に1人の水準にまで上昇している。

表1　連載の各回のタイトル

第1回	「健康の社会的決定要因」と健康格差を巡る動向
第2回	歯科疾患
第3回	子どもの問題行動
第4回	脳血管疾患
第5回	慢性腎臓病
第6回	メタボリックシンドロームと社会経済的地位
第7回	がんと社会経済的地位
第8回	認知症
第9回	高齢者の転倒・骨折
第10回	ソーシャルキャピタル
第11回	ライフコース疫学
第12回	健康格差への取り組みと健康影響評価
第13回	高齢者の低栄養と社会経済的地位
第14回	医療アクセスと健康格差
第15回	WHOの健康格差対策

本連載で紹介してきたように，貧困層や失業者，非正規雇用者の人たちに不健康が多いことを裏付ける膨大な研究が海外で蓄積されていることから，日本における研究が少なかっただけで，健康格差が存在する可能性は高い。実際，ここ数年間に日本の高齢者[2]や子ども[3]を対象に調べた結果が発表され，日本にも健康格差があることが明らかになってきている。

WHO（世界保健機関）は，健康格差問題を重視して，2009年の総会決議で取り上げ，加盟国にこの問題に取り組むことを求めている。日本でも，WHOの勧告などを参考にして対策を始める必要がある。そこで，本連載の最終回では，健康の社会的決定要因が，WHOなどでなぜこれほど重視されるようになったのか，その背景と意義を確認し，どのような対策を取るべきなのか，WHOの動向を中心に紹介する。

なぜ健康の社会的決定要因が注目されるのか

「健康の社会的決定要因」の重視は，公衆衛生の分野において，おそらくプライマリヘルスケアやヘルスプロモーションに匹敵する10年単位でみるべき大きな潮流の変化と思われる。どのように潮目が変わろうとしているのか，その背景や新しい潮流の向かう方向を確認しておくことは，新しい対策を考える上で有益と思われる。

少なくとも，1. 医学・医療技術の限界，2. 生活習慣変容の難しさ，3. 健康格差の3つの背景・要因が上げられる。

1.　医学・医療技術の限界

WHOが創立されてから，感染症に対するワクチンや抗生剤，低栄養や栄養素不足に対する栄養(素)補充など，根本レベルで原因を除去する本質的な技術が多数登場してきた。それによって，乳幼児死亡などは劇的に改善した。次々と開発された医学・医

療技術は，多くの健康問題の解消に大きな貢献をしてきた。

しかし，技術では解決しない問題が残ってしまった。技術があっても，その費用が高かったり，提供してくれる所が近くになかったりするなど，アクセスの問題である。例えば，貧困や低所得，失業や非正規雇用など社会から排除された人達，社会階層の低い人達である。保険料が払えず無保険になったり，保険証はあっても窓口負担額を払えないからと受診を我慢したり，無料や安価な健診制度があってもそのことを知らなかったり，日々の生活に追われて利用しない人たち，あるいは受けられるケアの質が低い人たちが存在する[4]。いくら技術が開発されても，それにアクセスできず，利用できなければ，効果はない。このような人たちの健康問題を解決するために必要なのは，もっと医療技術を開発することでなく，アクセスや利用においてバリアになっている社会経済的な要因を除去することである。

2.　生活習慣変容の難しさ

感染症のコントロールがある程度できるようになるにつれ非感染性疾患の重要性が増した。その代表が，健康に好ましくない生活習慣の蓄積による生活習慣病である。生活習慣が原因であることを情報提供すれば生活習慣は改善されると期待され健康教育が強化された。しかし，いくら情報を提供しても行動変容を起こし生活習慣が変わらなければ効果はない。そのため行動科学の知見に基づき行動変容をもたらすための技術も開発された。それらのプログラムの効果は，エビデンスの質が高い無作為化対照比較試験（Randomized Controlled Trial, RCT）などで検証された。しかしそれらは，比較的少数例を対象とし，理想的な研究条件下，言い換えれば非日常における短期的な効果であった。日常生活の影響が及ぶ長期的な効果[5]や，より多数例の集団を対象にした地域介入研究[6]の systematic review では十分な効果は認められなかった。その象徴が，我が国だけでなく欧米でも，万病のもととして，対策が強化されたにも関わらず減るどころかむしろ増加してきた肥満である。

生活習慣の改善が必要なのはどのような人たちなのか，情報提供・健康教育中心の行動変容アプローチはどのような人たちに影響が及びにくいのか，を調べてみると，本連載で紹介してきたように，その中には社会階層の低い人たちがいた。やはり社会的決定要因が，生活習慣変容の難しさの背景にあったのである。

3.　健康格差

もう一つは，無視できない社会階層間における健康格差が，国際間だけでなく1つの国の中でも見られることが判明してきたことである。基本的人権である「いのち」にまで小さくはない格差があること，しかもそれが拡大傾向を示していることが明らかになってきた。その時「すべての人に健康を Health for All」をスローガンに掲げてきた WHO は，これは健康の公正さ（equity）に関わる社会正義（social justice）[7]の問題だとして総会決議[8]でまで取り上げて，加盟国に行動を起こすことを求めたのである。その中で，強調されたのが健康の社会的決定要因に着目し，保健・医療以外の部門（non-health sector）にも働きかけることであった。

これらの背景要因を見ると，ここ数十年間の努力にも関わらず残された健康問題の根本的な原因として「健康の社会的決定要因」が避けては通れない中心的な課題として浮上してきたことがわかる。健康の社会的決定要因に対する取り組みは，成果が上がるには一世代くらいの（in a generation）時間がかかるであろうが[7]，多くの分野で徐々に浸透していくことが期待される。健康教育も，具体的にどうすれば，どれ位の効果があるのか，エビデンスが整ってから強化されたわけではない。それと同様に，健康の社会的決定要因への着目と介入策の開発は，その必要性を根拠に試みを重ね，その効果の検証が，少しずつ進められていくのだろう。

重視される3つの考え方

健康の社会的決定要因への取り組みで重視される考え方には少なくとも3つある。

1.　上流にある根本的な原因へのアプローチ

一つ目は，問題の「原因 cause」に着目するだけでなく，「原因の原因 cause of cause」に着目することである。川に例えれば，健康問題は，川の下流で起きている問題であり，それを克服するために，より上流（upstream）にある根本的な原因（root cause）にアプローチすることである。

ライフコース疫学の知見に基づき，成人期の健康問題であっても，青年期や小児期，出生時期，さらには親世代へと原因を遡って対策を考えるライフコース・アプローチもこの考え方の1つと言えるだろう。だから根本原因である社会格差そのものの是正をも，WHO は勧告の中に含めている。

2.　すべての政策において健康を考える

アデレイド宣言[9]で，スローガンとされたのが

「Health in All Policies（HiAP）」である。「原因の原因 cause of cause」を上流に探し出し，ライフコース・アプローチで迫ろうとすると，もはや保健・医療の枠内の政策だけでは対応できない。だから保健・医療専門職といえども，健康格差問題にはなすすべがないという立場は取っていない。逆に保健・医療以外の部門（non-health sector）にもアプローチしようとWHOは宣言した。例えば，交通政策担当部局や都市計画部門に対し，その地域に生活している人達の歩行量を増やすという視点から政策を見直したり，今後の計画を立てたりするように働きかけることを含んでいる。

3. 環境への介入

行動の変容を起こす方法には2つある。行動の主体である個人に働きかける方法と，環境に介入して健康に望ましい行動を取りやすい環境に変え，その結果その中で暮らす人々の行動を望ましいものに変えていく方法である。また予防医学にはリスク因子を持つ個人に対するハイリスク戦略と人口集団全体に対するポピュレーション戦略という2つの戦略もある。これらを組み合わせることが必要で，例えば，喫煙者に対する禁煙指導がハイリスク戦略にたつ個人への介入例であり，職場や公共空間の禁煙やたばこ税の引き上げなどがポピュレーション戦略にたつ環境への介入の例である。

生活習慣の変容の難しさが明らかになるにつれ，ハイリスク戦略単独でなくポピュレーション戦略を併用する重要性が明らかになってきた。またポピュレーション戦略の中でも従来から行われてきた健康情報の普及でなく，健康に良い環境づくりが重視されるようになってきた。さらに環境にも自然環境や物理的な環境だけでなく，社会経済的な環境も健康に影響を及ぼしていることが分かってきた。一例をあげれば，近くに公園や歩道が整備されている住宅地，公共交通機関が発達していて車に頼らず歩行量が増える地域という一見物理的な環境＝「原因 cause」も，そこに住居を買ったり借りたりしたくても，それが叶わない「原因の原因 cause of cause」は，経済力の問題であったりする。注目されるようになってきたソーシャル・キャピタルも社会的な環境の1つと言える。

健康格差の背景には，社会階層の低い人達ほど，劣悪な環境条件におかれていることがある。そのことが明らかになるにつれ，ポピュレーション戦略や環境への介入が重要視されるようになってきている。

WHOの方針文書

WHOの「健康の社会的決定要因委員会」は最終報告（2008）[7]で3つの勧告を掲げ，それは2009年総会決議にも反映された。2010年に，Adelaide宣言[9]で保健医療の枠を超えた取り組みの必要性を提唱した一方で，公衆衛生のプログラムの中で取り組むべきことについても文書[10]を出している。

1.「健康の社会的決定要因委員会」の3つの勧告

第1に，日常生活の条件-人々が生まれ育ち，生活，労働，そして年を重ねていく環境を改善すること，第2に，日常生活の条件の格差の元となる権力やお金，そして資源における不平等を，世界・国内・地域において是正すること，第3に，健康格差を測定し，モニタリングし，活動を評価し，知識の基盤を拡充し，健康の社会的決定要因について訓練された人材開発を進め，健康の社会的決定要因に関する社会の認識を高めることである。政策による健康（の公正）への影響をアセスメントする健康（公正）インパクト評価 Health（Equity）Impact Assessment, H(E)IAをすべきである。

2. アデレイド宣言

健康の社会的決定要因に影響する政策の多くは，保健・医療を専門としない部門（non-health sector）が立案・施行する政策である。したがって，すべての政策において健康の視点を考慮する“Health in All Policies（HiAP）”が必要である。非保健部門との協力した取り組みの例として，経済と雇用，治安と正義，教育と人生早期，農業と食糧，社会基盤と国土・土地利用計画，交通，環境と持続可能性，住宅とコミュニティサービス，国土と文化などがあげられている。

3. 公衆衛生プログラム

アルコールやタバコ，循環器疾患や糖尿病，メンタルヘルスなど12の公衆衛生プログラムにおける健康の社会的決定要因へのアプローチの仕方に関する文書である。

これらに共通する分析の枠組みとして図1の5段階を示し，最後に個人レベルの健康状態の差異がもたらされる要因を4段階に分けている。直接的には個人が受けられたヘルスケアの結果における差異が認められるが，それ以前に有害な社会物理的な環境への曝露における差異があり，同じ要因に同程度に曝露されても発症のしやすさなど対象グループの虚弱性の差異もある。それらのさらに上流には，社会

図1　公衆衛生状態の分析枠組み[10)]

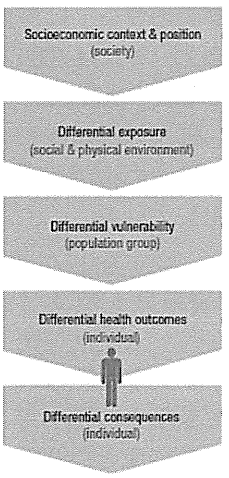

表2　影響経路における社会的決定要因[10)]

公衆衛生状態のフレームワーク上のレベル	主な社会的決定要因
社会経済的な文脈と位置：社会	グローバリゼーションと都市化 社会的地位と不平等 ジェンダー マイノリティーの状態と社会的排除 人口高齢化を含む急速な人口学的な変化
曝露因子の差異：社会的物理的環境	社会規範 コミュニティの環境と社会的基盤 不健康で有害な消費物 規制のない市場 広告とテレビへの曝露
虚弱性の差異：対象グループ	貧困と失業 到達が難しい対象集団 ヘルスケアへのアクセスの困難さ 不十分な教育と知識 タバコと薬物依存 家庭とコミュニティの機能不全 望ましくない食の安全と栄養
ヘルスケアの結果における差異：個人	治療とケアにおける質の悪さと差別 患者との関わりの不十分さ
結果の差異：個人	社会・教育・雇用・経済的な結果 社会的排除とスティグマ 保険からの排除

経済的な文脈や社会経済的な位置がどのようなものかという社会レベル要因もある。これらが重層的に重なって健康格差は起きている。この5つのレベル毎に健康の社会的決定要因を，示したのが表2である。これらについて，公衆衛生の課題毎に分析し，5つのレベルそれぞれにおいて，重要な健康の社会的決定要因を見定め，そこに介入できる可能性がある。そして，どのような取り組みによってどれ位の効果がどのような人たちに見られるのか，その効果を評価して，取り組み方を改善しながら進めていくことが必要である。

健康の社会的決定要因へのアプローチの潜在的可能性

WHOは，2011年10月に健康の社会的決定要因に関する国際会議（World Conference on Social Determinants of Health）をブラジルで開催する。大臣級が参加するハイレベル会議として位置づけられているという。

「上流にある根本原因へのアプローチ」「すべての政策において健康を考える」「環境への介入」などを特徴とする健康の社会的決定要因へのアプローチは，医学・医療技術や生活習慣に焦点をあてた取り組みと比べ，より困難なものである。しかし，それが展開された時の潜在的な可能性は大きい。それらによって禁煙や身体活動量の増加，食生活の改善，心理社会的なストレスの軽減などが進めば，本連載で見てきたように，1つの疾患だけでなく，ほとんどの生活習慣病やストレス起因性の状態や疾患全体の抑制につながると期待できる。それは，かつて抗結核薬など疾患特異的な技術の登場よりも前から，衛生環境の改善によって感染症全般が減って死亡率の逓減が進んできたことや，メタボリック症候群対策が進めば，高血圧も糖尿病も脂質異常症も改善に向かうことに似ている。その取り組みは簡単なものとは言えないが，それでも取り組む意義が大きいものなのである。

日本においても，WHOの勧告に沿った動きが，まずは学術分野で始まっている。日本公衆衛生学会のモニタリング・レポート委員会に，社会格差と健康ワーキンググループが設置され，子ども[11)]，就労世代，高齢者[12)]を対象とした3つのレポートと勧告の発表・準備が進められている。また，日本学術会議も基礎医学委員会と健康・生活科学委員会合同のパブリックヘルス科学分科会で，健康社会格差に関する提言を今期にまとめるべく作業が進められている。

健康格差対策には健康の社会的決定要因への着目とHiAPの視点，非保健・医療分野の参加が不可欠だが，それを始めるのは，非保健・医療職ではないであろう。まずは日本公衆衛生学会を中心とする公衆衛生専門職が，健康格差と健康の社会的決定要因の重要性について理解を深め，まわりに働きかける

ことから始まる。我が国でも，WHOの勧告や動きなどが浸透し，独自の努力や試行錯誤を経ながら展開されていくために，本連載が少しでも役立つことを願っている。

謝辞　本連載は，私立大学戦略的研究基盤形成支援事業並びに厚生労働科学研究費補助金（H22-長寿-指定-008）の研究成果の一端である。記して深謝します。

文　献

1) OECD. Income Distribution-Poverty. http://stats.oecd.org / Index.aspx?QueryId = 9909&QueryType = View（2011年6月12日アクセス可能）
2) 近藤克則．検証『健康格差社会』：介護予防に向けた社会疫学的大規模調査．東京：医学書院，2007.
3) 阿部　彩．子どもの健康と貧困の経験．平成19年度厚労科学研究費補助金（統計情報総合研究事業）総括研究報告書　パネル調査（縦断調査）に関する総合的分析システムの開発研究（主任研究者　金子隆一）2008; 205-216.
4) Frieden TR, Centers for Disease Control and Prevention. CDC health disparities and inequalities report: United States, 2011. Morbidity and Mortality Weekly Report 2011; 60(Suppl 01): 1-2.
5) Hooper L, Bartlett C, Davey Smith G, et al. Systematic review of long term effects of advice to reduce dietary salt in adults. BMJ 2002; 325: 628.
6) Pennant M, Davenport C, Bayliss S, et al. Community programs for the prevention of cardiovascular disease: a systematic review. American Journal of Epidemiology 2010; 172: 501-516.
7) Commission on Social Determinants of Health. Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health. Geneva: The World Health Organization, 2008. http://whqlibdoc.who.int / publications / 2008 / 9789241563703 _ eng.pdf（2011年6月12日アクセス可能）
8) World Health Organization. Resolutions WHA 62.14 Reducing Health Inequities through Action on the Social Determinants of Health. 2009. http://apps.who.int/gb/ebwha / pdf_files / WHA62-REC1 / WHA62_REC1-en-P2.pdf（2011年6月12日アクセス可能）
9) World Health Organization. Adelaide Statement on Health in All Policies: Moving towards a Shared Governance for Health and Well-Being. Report from the International Meeting on Health in All Policies World Health Organization (WHO). 2010. http://www.who.int/social_determinants/hiap_statement_who_sa_final.pdf（2011年6月12日アクセス可能）
10) Blas E, Kurup AS. Equity, Social Determinants and Public Health Programmes. Geneva: World Health Organization, 2010.
11) 日本公衆衛生学会公衆衛生モニタリング・レポート委員会．公衆衛生モニタリング・レポート(3)　子どもの健康と社会格差：低出生体重の健康影響．日本公衛誌 2011; 58: 212-215.
12) 日本公衆衛生学会公衆衛生モニタリング・レポート委員会．公衆衛生モニタリング・レポート(5)　高齢者における健康の社会格差．日本公衛誌 2011; 58: 564-568.

OPEN ACCESS Freely available online

PLOS ONE

Social Participation and Dental Health Status among Older Japanese Adults: A Population-Based Cross-Sectional Study

Kenji Takeuchi[1]*, Jun Aida[1], Katsunori Kondo[2], Ken Osaka[1]

1 Department of International and Community Oral Health, Tohoku University Graduate School of Dentistry, Miyagi, Japan, 2 Center for Well-being and Society, Nihon Fukushi University, Aichi, Japan

Abstract

Background: Although social participation is a key determinant of health among older adults, few studies have focused on the association between social participation and dental health. This study examined the associations between social participation and dental health status in community-dwelling older Japanese adults.

Methods and Findings: In 2010, self-administered postal questionnaires were distributed to all people aged $ 65 years in Iwanuma City, Japan (response rate, 59.0%). Data from 3,517 respondents were analyzed. Data on the number of remaining natural teeth, for determining the dental health status, and social participation were obtained using self-administered questionnaires. The number, type, and frequency of social activities were used to assess social participation. Social activities were political organizations or associations, industrial or professional groups, volunteer groups, senior citizens' clubs, religious groups or associations, sports groups, neighborhood community associations, and hobby clubs. Using ordinal logistic regression, we calculated the odds ratios (OR) and 95% confidence intervals (95% CI) for an increase in category of remaining teeth based on the number, type, and frequency of social activities. Sex, age, marital status, current medical history, activity of daily living, educational attainment, and annual equivalent income were used as covariates. Of the respondents, 34.2% reported having $ 20 teeth; 27.1%, 10–19 teeth; 26.3%, 1–9 teeth; and 12.4%, edentulousness. Social participation appeared to be related with an increased likelihood of having a greater number of teeth in old age, even after adjusting for covariates (OR = 1.30, 95% CI = 1.10–1.53). Participation in sports groups, neighborhood community associations, or hobby clubs was significantly associated with having more teeth.

Conclusions: Our results suggest a protective effect of social participation on dental health. In particular, participation in sports groups, neighborhood community associations, or hobby clubs might be a strong predictor for retaining more teeth in later life.

Citation: Takeuchi K, Aida J, Kondo K, Osaka K (2013) Social Participation and Dental Health Status among Older Japanese Adults: A Population-Based Cross-Sectional Study. PLoS ONE 8(4): e61741. doi:10.1371/journal.pone.0061741

Editor: Michael Glogauer, University of Toronto, Canada

Received October 19, 2012; Accepted March 15, 2013; Published April 17, 2013

Funding: The study was supported in part by a Strategic Research Foundation Grant-Aided Project for Private Universities grant from the Ministry of Education, Culture, Sports, Science, and Technology, Japan (MEXT http://www.mext.go.jp/english/), 2009–2013, Comprehensive Research on Aging and Health (24140701), and Grant-in-Aid for Scientific Research (B) (22390400 &24390469) and (C) (22592327) from the Japan Society for the Promotion of Science (JSPS http://www.jsps.go.jp/). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* Email: t.kenji64@gmail.com

Introduction

Enhanced social participation, a social determinant of health [1,2], is one of the 3 pillars of a World Health Organization (WHO) policy framework for an active aging society [3]. Social participation is a source of social relations and describes a person's participation in formal and informal group activities [4,5,6]. As many older retired people are assumed to have more time to participate in other activities, the role of social participation in the health of older adults is increasing in today's aging society.

Previous studies have examined the association between social participation and various health outcomes. A meta-analysis determined that social participation reduced the risk for mortality and that the magnitude of this effect was comparable with smoking cessation [7]. A study conducted in Asia reported that maintaining or initiating social participation in later life benefited the mental health of older adults [8]. A study conducted in Japan reported that lack of social participation was significantly related to an increased risk for onset of long-term care insurance certification [9]. In addition to the effect itself, social participation is important because it is a component of social capital [10]. According to Putnam, social capital refers to "features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" [11]. Recent studies have demonstrated a positive association between social capital and various health outcomes, including dental health [12,13,14,15,16,17].

Social participation is also considered to affect dental health [18,19]. Previous studies have demonstrated that lower levels of social participation were associated with a higher risk for

edentulism [18] or periodontitis [19]. There are 2 plausible relationship mechanisms between social participation and dental health: social network as a main effect, and stress buffering [20]. The main effect of social participation is obtained from social relationships, and this mechanism is beneficial regardless of whether individuals are under stress. Participation in a broad range of social relationships develops a person's social network. Individuals in a social network are subject to social controls and peer pressure that influence normative dental health behaviors (e.g., developing good dental habits and quitting smoking). For example, the cessation of smoking in one person appears to be highly related to the smoking behavior of others nearby in that person's social network [21]. Social network ties also provide multiple sources of information that could influence behaviors relevant to oral health, result in the effective use of available dental health services, or help people avoid stressful or other high-risk situations. In addition to this main effect, stress buffering is also considered a pathway to good dental health. A systematic review of the literature suggests that psychological stress causes periodontal disease, which is a key risk factor for tooth loss [22]. Social networks are a source of social support, which in turn provides psychological and material resources intended to benefit an individual's ability to cope with stress. As social support promotes less threatening interpretations of adverse events and effective coping strategies, it can shield individuals from the effects of stressful experiences. This mechanism is called stress buffering.

Despite a recent increase in studies on social participation and health, only a small number of studies have focused on the association between social participation and oral health. In addition, previous oral epidemiological studies have defined social participation as only belonging or not belonging to social relationships, or as high or low frequency of social engagement. A meta-analysis revealed that definitions of social participation mostly focused on questions of who, how, what, with whom, and where [6]. To our knowledge, the present study is the first to focus on the number, type, and frequency of social activities. This study aimed to quantify the associations between social participation and dental health status in community-dwelling older Japanese adults.

Methods

Study sample

The present analysis was based on a subset of the Japan Gerontological Evaluation Study (JAGES) project data. The JAGES project is an ongoing prospective cohort study investigating factors associated with the loss of health related to functional decline or cognitive impairment among individuals aged 65 years or older. In 2010, self-administered postal questionnaires were distributed to all people aged $ 65 years in Iwanuma City, Miyagi Prefecture, Japan (n = 8,576), and 5,058 (response rate, 59.0%) people returned the questionnaires. After excluding respondents who failed to provide information on sex, dental health status, or social participation, the data from 3,517 respondents were analyzed. If the respondents did not respond to the other variables, the corresponding observations were assigned to "missing" categories. Ethical approval for the study was obtained from the Ethics Committee at Tohoku University and Nihon Fukushi University.

Outcome variable

The number of remaining natural teeth, derived from responses collected through the self-administered questionnaire, was used as an indicator of dental health status. Respondents were asked to classify their dental health status into one of 4 categories: $ 20 teeth remaining, 10–19 teeth remaining, 1–9 teeth remaining, or no teeth remaining.

Main predictors

Social participation was defined as the person's involvement in social activities. First, respondents were asked whether they belonged to political organizations or associations, industrial or professional groups, volunteer groups, senior citizens' clubs, religious groups or associations, sports groups, neighborhood community associations, or hobby clubs. Second, respondents were asked to indicate the frequency of participation in each group: 2–3 times per week, once per week, several times per month, several times per year, or almost never. As there were very few "2–3 times per week" responses for 6 groups (political organizations or associations, industrial or professional groups, volunteer groups, senior citizens' clubs, religious groups or associations, and neighborhood community associations), we re-categorized these social participation variables: once or more per week, several times per month, several times per year, almost never. As our study also focused on the number of social activities, we calculated the numbers of social activities and created 6 categories: 0 groups, 1 group, 2 groups, 3 groups, 4 groups, and $ 5 groups.

Covariates

It was assumed that physical health status was associated with both social participation and dental health status. Activity of daily living and current medical history were used as indicators of physical health status. Activity of daily living was categorized as independent, partially dependent, and dependent. Current medical history was measured by the question, "Do you receive treatment now?" to which respondents answered "yes" or "no." Sex, age, and marital status were used as socio-demographic characteristics. Age groups were categorized as 65–69, 70–74, 75–79, 80–84, and $ 85 years. Marital status was categorized as married, widowed, separated, never married, and other. Educational attainment and annual equivalent income were used as indicators of socioeconomic status. Educational attainment was categorized as , 6, 6–9, 10–12, and $ 13 years. Annual equivalent income was divided into quartiles: lowest, low-middle, high-middle, and highest.

Statistical analysis

Descriptive statistics were used to characterize the respondents. We performed ordinal logistic regressions to examine the associations between social participation and dental health status. We calculated the odds ratios (OR) and 95% confidence intervals (95% CI) for an increase in the remaining teeth category based on the number, type, and frequency of social activities. To estimate the overall effect of social participation, we used a dichotomized variable of social participation (1 = participating in $ 1 groups, 0 = not participating in any group). Variables on social participation were included separately in the different models. In the univariate model (Model 1), we calculated the crude OR for dental health status based on the number of social activities and the type and frequency of social participation. In the multivariable model (Model 2), we added all covariates into the univariate model. In order to assess the public health impact of social participation, we calculated the population-attributable fraction (PAF) of having $ 20 teeth to social participation. The PAF is generally defined as the reduction in the burden of disease (or risk factor) that would be achieved if the population had been entirely unexposed, compared with its current exposure pattern [23]. In this study, we treated the PAF as the increase in the number of people with $ 20 remaining

teeth that would be achieved if the entire population participated in some kind of social group, compared with its current participation pattern. We calculated a PAF for $ 20 remaining teeth because the retention of a minimum of 20 functional natural teeth at the age of $ 65 years is a goal for oral health specified by the WHO/ Federation Dentaire Internationale in 2000 [24]. The goal for an acceptable level of oral health determined by the Japan Dental Association is the retention of at least 20 functional teeth until the age of 80 years (8020 movement). A previous study also indicated that among older people, those with $ 20 teeth had higher food intakes than those with # 19 teeth [25]. All analyses were performed using SPSS statistical software (version 17.0, SPSS, Chicago, IL).

Results

The demographic and health characteristics of all respondents (n = 3,517; average age, 73.5 years for men and 75.0 years for women) in the study are shown in Tables 1 and 2. Of the respondents, 34.2% reported having $ 20 teeth, 27.1% reported having 10–19 teeth, 26.3% reported having 1–9 teeth, and 12.4% reported having no teeth. Of the respondents, 13.9% belonged to political organizations or associations, 15.2% to industrial or professional groups, 16.4% to volunteer groups, 15.7% to senior citizens' clubs, 7.3% to religious groups or associations, 24.5% to sports groups, 46.8% to neighborhood community associations, and 41.1% to hobby clubs.

Of all respondents, 69.6% participated in $ 1 groups, and 30.4% did not participate in any group. Compared to the non-participants, participants had significantly higher odds of having a greater number of teeth (OR = 2.40, 95% CI = 2.10–2.74). After adjusting for sex, age, marital status, current medical history, activity of daily living, educational attainment, and annual equivalent income, social participation appeared to be related with an increased likelihood of having a greater number of teeth in old age (OR = 1.30, 95% CI = 1.10–1.53).

Table 3 illustrates the association between dental health status and the number of social activities. Participating in $ 1 groups was significantly associated with odds of having more remaining teeth that were more than twice as high as compared with non-participation (Model 1). After adjusting for all covariates, participating in 4 groups was associated with significantly higher odds (OR = 1.46, 95% CI = 1.11–1.93) of having more remaining teeth compared with non-participation (Model 2). Table 4 shows the association between dental health status and the type and frequency of social participation. The groups significantly associated with a higher number of remaining teeth were industrial or professional groups, volunteer groups, sports groups, neighborhood community associations, and hobby clubs (Model 1). After adjusting for all covariates, participating in sports groups (2–3 times per week, OR = 1.31, 95% CI = 1.01–1.69), neighborhood community associations (several times per year, OR = 1.19, 95% CI = 1.02–1.39), or hobby clubs (2–3 times per week, OR = 1.36, 95% CI = 1.05–1.76; once per week, OR = 1.39, 95% CI = 1.10–1.75; several times per year, OR = 1.41, 95% CI = 1.11–1.81) was significantly associated with having more teeth (Model 2). With the exception of these 3 groups, although most types of participation were associated with higher odds of having more teeth, the associations were explained by covariates. This indicates that healthier people tend to have more teeth and participate in groups.

The PAFs, or the contribution of social participation to having $ 20 teeth, are shown in Tables 3 and 4. The PAFs for the number of social activities and 3 types of social participation variables that were significantly associated with dental health (i.e., sports groups, neighborhood community associations, and hobby clubs) were 7.5%–31.6%. The largest PAF (31.6%) was for participation in $ 1 social groups.

Table 1. Characteristics of respondents.

	n	%		n	%
Sex			Educational attainment (years)		
Men	1,681	47.8	, 6	86	2.4
Women	1,836	52.2	6–9	1,071	30.5
Age (years)			10–12	1,521	43.2
65–69	1,147	32.6	$ 13	762	21.7
70–74	950	27.0	Missing	77	2.2
75–79	649	18.5	Annual equivalent income (quartiles)		
80–84	418	11.9	Lowest	718	20.4
$ 85	346	9.8	Low-middle	731	20.8
Missing	7	0.2	High-middle	801	22.8
Marital status			Highest	792	22.5
Married	2,416	68.7	Missing	475	13.5
Widowed	855	24.3	Number of remaining natural teeth		
Separated	111	3.2	$ 20	1,203	34.2
Never married	50	1.4	10–19	952	27.1
Other	28	0.8	1–9	925	26.3
Missing	57	1.6	No	437	12.4
Current medical history			Number of social activities (groups)		
Yes	2,741	77.9	0	1,068	30.4
No	731	20.8	1	749	21.3
Missing	45	1.3	2	644	18.3
Activity of daily living			3	456	13.0
Independent	3,155	89.7	4	281	8.0
Partially dependent	208	5.9	$ 5	319	9.1
Dependent	122	3.5			
Missing	32	0.9			

doi:10.1371/journal.pone.0061741.t001

Discussion

Our study demonstrates a significant positive association between social participation and dental health status in a representative sample of men and women aged $ 65 years in a municipality in Japan. Among those with $ 20 remaining teeth, 31.6% of cases in the population might be attributed to participation in $ 1 social groups. To our knowledge, no published reports have examined the associations between dental health status and the number, type, and frequency of social activities. In relation to the type and frequency of social participation, frequent participation in sports groups, rare participation in neighborhood community associations, or participation in hobby clubs with little regard to frequency were significantly associated with dental health status, even after adjusting for demographic variables and social class indicators. In relation to the number of social activities, almost all amounts of social participation were significantly positively associated with dental health.

Our results may support the earlier-described mechanisms linking social participation and dental health status (i.e., social network as a main effect and stress buffering). There was a

Table 2. Characteristics of respondents according to type and frequency of social participation.

	2–3 times per week n (%)	Once per week n (%)	Several times per month n (%)	Several times per year n (%)	Almost never n (%)
Type and frequency of social participation					
Political organization or association	45 (1.3)	32 (0.9)	90 (2.6)	321 (9.1)	3,029 (86.1)
Industrial or professional group	56 (1.6)	36 (1.0)	126 (3.6)	318 (9.0)	2,981 (84.8)
Volunteer group	52 (1.5)	59 (1.7)	192 (5.5)	275 (7.8)	2,939 (83.6)
Senior citizens' club	27 (0.8)	61 (1.7)	185 (5.3)	280 (8.0)	2,964 (84.3)
Religious group or association	23 (0.7)	34 (1.0)	81 (2.3)	120 (3.4)	3,259 (92.7)
Sports group	259 (7.4)	245 (7.0)	183 (5.2)	176 (5.0)	2,654 (75.5)
Neighborhood community association	44 (1.3)	61 (1.7)	282 (8.0)	1,260 (35.8)	1,870 (53.2)
Hobby club	284 (8.1)	350 (10.0)	500 (14.2)	311 (8.8)	2,072 (58.9)

doi:10.1371/journal.pone.0061741.t002

significant association with better dental health status for participants in the groups with higher social participation rates. In groups with high participation rates that include many social ties, people may easily develop social networks and receive social support.

In addition to these positive effects of social participation on health, social participation can have negative effects on health. Social networks provide opportunities for conflict, exploitation, stress transmission, misguided attempts to help, and feelings of loss and loneliness [20]. These potentially negative aspects of social networks can cause psychological stress, which in turn adversely affects dental health. The results of this study showed no significant association between frequent participation in neighborhood community associations and dental health, but there was a significant association between relatively rare participation and dental health. The negative effects of social participation on health may be a reason for this. Participation in neighborhood community associations might include obligatory activities characterized by the negative aspects of social networks. People who frequently participate in obligatory activities may experience stress, leading to oral disease. Therefore, frequent participation in neighborhood community associations might not be significantly associated with having more teeth. Similarly, where participation in $ 5 groups is concerned, social participation might not be significantly associated with having more teeth for an increase in the type of social participation that has negative effects on health.

Our findings are generally consistent with those of previous studies indicating that participating in social activities benefits dental health status among middle-aged and older people. Rodrigues et al. suggested that social participation is significantly associated with a lower prevalence of edentulism among older adults [18]. Merchant et al. also suggested that men who participate in religious meetings are associated with a reduced risk of developing periodontitis [19].

To our knowledge, no study has specifically examined the differences between men and women in relation to the association between social participation and dental health status, though previous work has indicated that such differences exist. Among women, participation in social networks may increase levels of psychological stress [26]. In our study, 75.3% of men participated in $ 1 groups compared to 64.5% of women. However, with respect to the main results, we found few differences between men and women.

The results of this study have public health implications. Our goal was to estimate the PAF associated with participation in social activities (compared to non-participation) for having $ 20 remaining teeth. The largest PAF (31.6%) was for participation in $ 1 social groups, which implies that in 31.6% of cases in the population, presence of $ 20 remaining teeth may be attributed to

Table 3. Association of dental health status with number of social activities determined by ordinal logistic regression.

	Model 1	Model 2		
	Crude OR (95% CI)	Adjusted OR[a] (95% CI)	n of ≥20 teeth (%)	PAF[b] (%)
Number of social activities (groups)				31.6
0	1.00	1.00	250 (23.4)	
1	2.21 (1.86–2.62)	1.31 (1.07–1.59)	279 (37.2)	
2	2.22 (1.85–2.65)	1.21 (0.98–1.49)	231 (35.9)	
3	2.84 (2.32–3.48)	1.36 (1.07–1.72)	194 (42.5)	
4	2.90 (2.28–3.70)	1.46 (1.11–1.93)	125 (44.5)	
$ 5	2.31 (1.84–2.90)	1.25 (0.96–1.62)	124 (38.9)	

OR = odds ratio; CI = confidence interval.
[a]Odds ratio adjusted for sex, age, marital status, current medical history, activity of daily living, educational attainment, and annual equivalent income.
[b]Population-attributable fraction.
doi:10.1371/journal.pone.0061741.t003

Table 4. Association of dental health status with type and frequency of social participation determined by ordinal logistic regression.

	Model 1	Model 2		
	Crude OR (95% CI)	Adjusted OR[a] (95% CI)	n of ≧20 teeth (%)	PAF[b] (%)
Type and frequency of social participation				
Political organization or association				1.4
Once or more per week	1.15 (0.77–1.74)	0.97 (0.61–1.53)	26 (33.8)	
Several times per month	1.33 (0.91–1.95)	1.06 (0.69–1.61)	35 (38.9)	
Several times per year	1.14 (0.93–1.41)	0.89 (0.70–1.11)	120 (37.4)	
Almost never	1.00	1.00	1,022 (33.7)	
Industrial or professional group				3.6
Once or more per week	1.29 (0.88–1.87)	1.03 (0.68–1.58)	33 (35.9)	
Several times per month	1.75 (1.26–2.44)	1.17 (0.82–1.67)	55 (43.7)	
Several times per year	1.51 (1.22–1.87)	1.05 (0.83–1.32)	132 (41.5)	
Almost never	1.00	1.00	983 (33.0)	
Volunteer group				4.3
Once or more per week	1.38 (0.98–1.96)	1.11 (0.76–1.61)	44 (39.6)	
Several times per month	1.85 (1.41–2.42)	1.31 (0.97–1.76)	89 (46.4)	
Several times per year	1.37 (1.10–1.72)	1.02 (0.79–1.31)	108 (39.3)	
Almost never	1.00	1.00	962 (32.7)	
Senior citizens' club				2 1.7
Once or more per week	0.76 (0.52–1.12)	0.89 (0.58–1.36)	27 (30.7)	
Several times per month	0.77 (0.59–1.01)	0.76 (0.56–1.02)	58 (31.4)	
Several times per year	0.80 (0.65–1.00)	0.89 (0.70–1.14)	87 (31.1)	
Almost never	1.00	1.00	1,031 (34.8)	
Religious group or association				0.4
Once or more per week	0.99 (0.61–1.58)	0.87 (0.51–1.48)	18 (31.6)	
Several times per month	1.06 (0.71–1.58)	1.07 (0.68–1.68)	28 (34.6)	
Several times per year	1.34 (0.96–1.87)	1.31 (0.90–1.90)	47 (39.2)	
Almost never	1.00	1.00	1,110 (34.1)	
Sports group				7.5
2–3 times per week	1.90 (1.50–2.41)	1.31 (1.01–1.69)	115 (44.4)	
Once per week	1.73 (1.36–2.20)	1.20 (0.92–1.56)	104 (42.4)	
Several times per month	1.64 (1.25–2.16)	0.99 (0.74–1.34)	75 (41.0)	
Several times per year	1.54 (1.17–2.04)	1.02 (0.75–1.39)	69 (39.2)	
Almost never	1.00	1.00	840 (31.7)	
Neighborhood community association				14.5
Once or more per week	1.42 (0.99–2.02)	0.98 (0.65–1.47)	34 (32.4)	
Several times per month	1.63 (1.30–2.05)	0.93 (0.72–1.19)	100 (35.5)	
Several times per year	1.83 (1.60–2.08)	1.19 (1.02–1.39)	522 (41.4)	
Almost never	1.00	1.00	547 (29.3)	
Hobby club				16.8
2–3 times per week	1.98 (1.58–2.49)	1.36 (1.05–1.76)	122 (43.0)	
Once per week	2.06 (1.67–2.54)	1.39 (1.10–1.75)	157 (44.9)	
Several times per month	1.84 (1.54–2.20)	1.16 (0.95–1.42)	194 (38.8)	
Several times per year	2.13 (1.71–2.65)	1.41 (1.11–1.81)	140 (45.0)	
Almost never	1.00	1.00	590 (28.5)	

OR = odds ratio; CI = confidence interval.
[a]Odds ratio adjusted for sex, age, marital status, current medical history, activity of daily living, educational attainment, and annual equivalent income.
[b]Population-attributable fraction.
doi:10.1371/journal.pone.0061741.t004

participation in $ 1 social groups. Similarly, the PAFs for participation in sports groups, neighborhood community associations, and hobby groups were 7.5%, 14.5%, and 16.8%, respectively, for having $ 20 remaining teeth. Therefore, promoting and supporting opportunities for social participation, especially in sports groups, neighborhood community associations, or hobby clubs, as a public health intervention may contribute to an increase in the number of older people with $ 20 remaining teeth.

Our study has several limitations as well as strengths. First, the response rate was moderate (59.0%); hence, our results may have been affected by selection bias. Second, our research data were derived from self-reported questionnaires, raising issues of information bias regarding the true number of remaining teeth. However, self-reports have yielded reasonably valid estimates for the number of teeth in national epidemiological surveys in several prior studies [27,28]. In a study of 2,496 Japanese older people, the difference between the self-reported number of teeth and the clinically examined number of teeth was very small and insignificant according to the t-test, and the correlation between the 2 groups was very high ($r = 0.93$) [28]. Therefore, it is reasonable to assume that self-reported questionnaires can provide sufficiently reliable data about the number of remaining teeth. Third, our study was cross-sectional; therefore, it was not possible to generate any statements on causation. The present cross-sectional study could not exclude the possibility of reverse causation, in that people with good oral health tend to participate in social activities. Longitudinal studies or intervention studies are needed to examine the effects of social participation on dental health status. Lastly, our study participants were from one medium-sized municipality in Japan; hence, the generalizability of our results is limited. Caution should be exercised when interpreting our results, as it requires the somewhat strong assumption that the data we used for our analysis are generalizable to the entire population.

However, the population sample also could be considered a strength, as our data were less affected by geographic and cultural factors between municipalities, which provides some assurance of internal validity. The level of detail included in the social participation variable is another strength. Lastly, our data were reliable because all of the older residents in one city were recruited for our survey, and a large number of people participated.

Conclusion

Social participation was significantly and positively associated with better dental health status among older Japanese adults. Approximately one-third of the participants had $ 20 teeth, which may have been attributable to their participation in $ 1 social groups, though the present cross-sectional design could not exclude the possibility that people with good oral health tend to participate in social activities. In addition, our results indicate the possibility that participation in sports groups, neighborhood community associations, or hobby clubs in later life is protective of dental health beyond individual differences in demographic variables and social class indicators.

Acknowledgments

We are grateful to the subjects who participated in this study. This study used data from the JAGES. The Tohoku University and the Nihon Fukushi University Center for Well-being and Society conducted the survey as one of those research projects.

Author Contributions

Conceived and designed the experiments: KT JA KK KO. Performed the experiments: KT KO. Analyzed the data: KT JA. Contributed reagents/materials/analysis tools: KT JA KO. Wrote the paper: KT JA KK.

References

1. Marmot M, Shipley M, Brunner E, Hemingway H (2001) Relative contribution of early life and adult socioeconomic factors to adult morbidity in the Whitehall II study. J Epidemiol Community Health 55: 301–307.
2. McMunn A, Breeze E, Goodman A, Nazroo J, Oldfield Z (2005) Social determinants of health in older age. In: Marmot M, Wilkinson RG, editors. Social determinants of health. New York: Oxford University Press. pp. 267–296.
3. World Health Organization (2002) Active Ageing: a Policy Framework. Geneva, Switzerland: WHO.
4. Lindström M, Hanson BS, Ostergren PO (2001) Socioeconomic differences in leisure-time physical activity: the role of social participation and social capital in shaping health related behaviour. Soc Sci Med 52: 441–451.
5. Lindström M, Malmö Shoulder-Neck Study Group (2006) Psychosocial work conditions, social participation and social capital: a causal pathway investigated in a longitudinal study. Soc Sci Med 62: 280–291.
6. Levasseur M, Richard L, Gauvin L, Raymond E (2010) Inventory and analysis of definitions of social participation found in the aging literature: proposed taxonomy of social activities. Soc Sci Med 71: 2141–2149.
7. Holt-Lunstad J, Smith TB, Layton JB (2010) Social relationships and mortality risk: a meta-analytic review. PLoS Med 27; 7: e1000316.
8. Chiao C, Weng LJ, Botticello AL (2011) Social participation reduces depressive symptoms among older adults: an 18-year longitudinal analysis in Taiwan. BMC Public Health 11: 292.
9. Hirai H, Kondo K, Ojima T, Murata C (2009) Examination of risk factors for onset of certification of long-term care insurance in community-dwelling older people: AGES project 3-year follow-up study [in Japanese]. Nihon Koshu Eisei Zasshi 56: 501–512.
10. Harpham T, Grant E, Thomas E (2002) Measuring social capital within health surveys: key issues. Health Policy Plan 17: 106–111.
11. Putnam RD (1993) Making democracy work: civic traditions in modern Italy. New Jersey: Princeton University Press.
12. Aida J, Kuriyama S, Ohmori-Matsuda K, Hozawa A, Osaka K, et al. (2011) The association between neighborhood social capital and self-reported dentate status in elderly Japanese - the Ohsaki Cohort 2006 Study. Community Dent Oral Epidemiol 39: 239–249.
13. Furuta M, Ekuni D, Takao S, Suzuki E, Morita M, et al. (2012) Social capital and self-rated oral health among young people. Community Dent Oral Epidemiol 40: 97–104.
14. Murayama H, Fujiwara Y, Kawachi I (2012) Social capital and health: a review of prospective multilevel studies. J Epidemiol 22: 179–187.
15. Kawachi I, Kennedy BP, Glass R (1999) Social capital and self-rated health: a contextual analysis. Am J Public Health 89: 1187–1193.
16. De Silva MJ, McKenzie K, Harpham T, Huttly S (2005) Social capital and mental illness: a systematic review. J Epidemiol Community Health 59: 619–627.
17. Aida J, Hanibuchi T, Nakade M, Hirai H, Osaka K, et al. (2009) The different effects of vertical social capital and horizontal social capital on dental status: a multilevel analysis. Soc Sci Med 69: 512–518.
18. Rodrigues SM, Oliveira AC, Vargas AM, Moreira AN, E Ferreira EF (2012) Implications of edentulism on quality of life among elderly. Int J Environ Res Public Health 9: 100–109.
19. Merchant AT, Pitiphat W, Ahmed B, Kawachi I, Joshipura K (2003) A prospective study of social support, anger expression and risk of periodontitis in men. J Am Dent Assoc 134: 1591–1596.
20. Cohen S (2004) Social relationships and health. Am Psychol 59: 676–684.
21. Christakis NA, Fowler JH (2008) The collective dynamics of smoking in a large social network. N Engl J Med 358: 2249–2258.
22. Peruzzo DC, Benatti BB, Ambrosano GM, Nogueira-Filho GR, Sallum EA, et al. (2007) A systematic review of stress and psychological factors as possible risk factors for periodontal disease. J Periodontol 78: 1491–1504.
23. Rothman KJ, Greenland S, Lash TL (2008) Modern epidemiology (3rd ed.). Philadelphia: Lippincott Williams & Wilkins. pp. 51–70.
24. Federation Dentaire Internationale (1982) Global goals for oral health in the year 2000. Int Dent J 32: 74–77.
25. Yoshihara A, Watanabe R, Nishimuta M, Hanada N, Miyazaki H (2005) The relationship between dietary intake and the number of teeth in elderly Japanese subjects. Gerodontology 22: 211–218.
26. Kawachi I, Berkman LF (2001) Social ties and mental health. J Urban Health 78: 458–467.
27. Pitiphat W, Garcia RI, Douglass CW, Joshipura KJ (2002) Validation of self-reported oral health measures. J Public Health Dent 62: 122–128.
28. Ando Y, Ikeda S, Yoshihara A (1997) The reliability of self-assessment of number of remaining teeth using questionnaires [in Japanese]. J Dent Health 47: 657–662.

OPEN ACCESS Freely available online

PLOS ONE

Participation in Sports Organizations and the Prevention of Functional Disability in Older Japanese: The AGES Cohort Study

Satoru Kanamori[1]*, Yuko Kai[2], Katsunori Kondo[3], Hiroshi Hirai[4], Yukinobu Ichida[3], Kayo Suzuki[3], Ichiro Kawachi[5]

1 Faculty of Health and Care and Nursing, Juntendo University, Tokyo, Japan, 2 Physical Fitness Research Institute Meiji Yasuda Foundation of Health and Welfare, Hachioji, Japan, 3 Center for Well-being and Society, Nihon Fukushi University, Nagoya, Japan, 4 Faculty of Engineering, Department of Civil and Environmental Engineering, Iwate University, Morioka, Japan, 5 Department of Society, Human Development, and Health, Harvard School of Public Health, Boston, Massachusetts, United States of America

Abstract

Background: We sought to examine prospectively the difference in the association between incident functional disability and exercise with or without sports organization participation.

Methods: The study was based on the Aichi Gerontological Evaluation Study (AGES) Cohort Study data. In October 2003, self-reported questionnaires were mailed to 29,374 non-disabled Japanese individuals aged 65 years or older. Of these, 13,310 individuals were introduced to the Study, and they were followed for 4 years. Analysis was carried out on 11,581 subjects who provided all necessary information for the analysis.

Results: Analysis was carried out on incident functional disability by 4 groups of different combinations of performance of exercise and participation in a sports organization Active Participant (AP), Exercise Alone (EA), Passive Participant (PP) and Sedentary (S). Compared to the AP group, the EA group had a hazard ratio (HR) of 1.29 (1.02–1.64) for incident functional disability. No significant difference was seen with the PP group, with an HR of 1.16 (0.76–1.77). When a measure of social networks was added to the covariates, the HR of the EA group dropped to 1.27 (1.00–1.61), and significant differences disappeared. In contrast, it showed hardly any change when social support was added.

Conclusion: The results suggested that, even with a regular exercise habit, incident functional disability may be better prevented when a person participates in a sports organization than when he/she does not. In addition, participation in a sports organization correlates positively with social networks, which may lead to a small decrease in incident functional disability.

Citation: Kanamori S, Kai Y, Kondo K, Hirai H, Ichida Y, et al. (2012) Participation in Sports Organizations and the Prevention of Functional Disability in Older Japanese: The AGES Cohort Study. PLoS ONE 7(11): e51061. doi:10.1371/journal.pone.0051061

Editor: Alejandro Lucia, Universidad Europea de Madrid, Spain

Received July 24, 2012; Accepted October 29, 2012; Published November 30, 2012

Funding: This study was supported in part by MEXT-Supported Program for the Strategic Research Foundation at Private Universities, 2009-2013 and Grant-in-Aid for Scientific Research (23243070). 2The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* E-mail: skanamo@juntendo.ac.jp

Introduction

Over 1 in 5 people are 60 years or older in more developed regions today, and aging is predicted to advance in developing nations as well in the future, [1]. At 31.1% of the country's population, Japan has the largest proportion of people who are 60 years and older in the world, and the number of older people with incident functional disability is increasing as society continues to age, [2]. Reducing this number is an urgent task throughout the world.

Exercise is an effective way to prevent incident functional disability. Training programs that include special exercises have been reported to influence numerous factors related to functional disability, such as maintenance of physical functioning, [3], prevention of falls, [4] and improvement of cognitive functioning, [5]. Such special exercise training programs may not even be necessary; as links have also been shown between walking and physical activity that includes exercise, and a decrease in functional disability, [6–11].

While people may exercise alone, they may also join a group or organization to get exercise. Mechanisms for the effect of participation in organized sports on health may include not only physiological mechanisms through the increase in physical activity, but also mechanisms whereby social networks and social support are more easily obtained through the joining of a group or organization, [12]. Links have been shown between poor social relationships and a decline in functional status, [7] as well as death, [13,14]. This means that, in addition to physiological effects of exercise, getting exercise by participating in a sports organization may have additional effects from social

relationships which are not achieved in exercise without participation in an organization. To the best of our knowledge, the effect of the latter has not been tested in any studies to date. If participation in a sports organization is indeed more strongly linked to incident functional disability prevention than private exercise, approaches for incident functional disability prevention should involve increasing participation in a sports organization in addition to recommending private exercise.

This prospective cohort study of older Japanese people aimed to test the relationship between incident functional disability and differences in whether or not subjects exercised and/or participated in a sports organization.

Methods

Study Sample

The present study is based on the Aichi Gerontological Evaluation Study (AGES) Cohort Study data, [15,16]. This study involves investigating factors associated with incident functional disability among non-institutionalized elderly individuals aged 65 years or older. The region studied covered 6 municipalities in the Chita-hanto Peninsula of Aichi Prefecture, Japan (Handa city, Tokoname city, Agui town, Taketoyo town, Minamichita town and Mihama town). In October 2003, self-reported questionnaires were mailed to 29,374 community-dwelling individuals aged 65 years or older who were not eligible to receive benefits from public long-term care insurance (LTCI) services. The survey was conducted using a random sampling method in the 2 larger municipalities (Handa city and Tokoname city) and a complete census (complete enumeration) of the 4 smaller municipalities (Agui town, Mihama town, Minami-Chita town, and Taketoyo town) by municipal officers of the public LTCI system. The official residential registries were maintained by the municipal administrations, and the Japanese registries included information such as age. Questionnaires were sent to 5,000 people each from Handa city and Tokoname city and to all eligible people in the other municipalities. Of those, 13,310 individuals (6,508 males; 6,802 females) were introduced to the AGES Cohort. They were followed for a 4-year period starting in November 2003 (observation period: November 2003 to October 2007). Analysis was carried out on 11,581 subjects, excluding 319 people whose information on age or sex was missing, and 1,410 people who did not respond to questions on frequency of exercise and participation in a sports organization. Subjects were 5,700 males (49.2%) and 5,881 females (50.8%), and the mean age was 72.66 6.1 years. Baseline characteristics of the participants have been reported elsewhere, [15,16].

Ethical approval for the study was obtained from the Nihon Fukushi University Ethics Committee.

Incident Functional Disability

We defined the state of becoming eligible for certification of needed long-term care within the procedure prescribed in the LTCI system that has been in place in Japan since 2000 as "incident functional disability." Certification of needed long-term care is based on evaluation of the need for long-term care according to uniform criteria for all of Japan and based on both a home-visit interview and a written opinion from the primary physician, [17]. We obtained information on certification of needed long-term care, death, and moving out of the study area from the LTCI database maintained by the municipalities. The day certification of needed long-term care was issued was the application date for certification of needed long-term care.

Performing Exercise and Participation in a Sports Organization

To define exercise, subjects were asked "Do you engage in any leisure activities at the moment?" Those who answered "Yes" were then asked about the frequency of performing a sports activity such as ground golf, gateball [Japanese croquet], walking, jogging or any other physical exercises ("frequency of exercise"). Subjects who responded with "almost every day," "twice or three times a week," or "once a week" were labeled "Exercisers," and those who responded with "once or twice a month," "several times a year" or "I don't engage in any sports activities" were labeled as "Inactive." Those who responded with "No" to the first question were considered the same as those who responded with "I don't engage in any sports activities." To determine participation in a sports organization, subjects were asked if they are a member of a "sports group or club." Those who answered "Yes" were labeled "Participants" and those who answered "No" were labeled "Non-participants."

Covariates

Based on previous studies, [8–11,18], age, sex, annual equivalent income, educational attainment, marital status, occupational status, self-reported medical conditions, depression (Geriatric Depression Scale: GDS), [19], smoking and alcohol consumption were used as covariates that may correlate with participation in a sports organization, performance of exercise and incident functional disability. Social networks and social support were used to test which aspect of participation in a sports organization accounts for the prevention of incident functional disability, since previous studies indicate that social relations are important mediating factors in the mechanisms for the effect of participation in organized sports on health, [12]. Frequency of meeting friends was used as a measure of social networks, and social support was measured with four types: "receiving" and "providing" emotional and instrumental support.

Statistical Analysis

As shown in Table 1, subjects were first split into 4 groups based on whether or not they performed exercise and participated in a sports organization. Table 2 shows baseline characteristics and the incident rate of functional disability over 4 years for each group related to performance of exercise and participation in a sports organization. To test for group differences, one-way analysis of variance (ANOVA) was performed on age, and x2 tests were performed on sex, frequency of exercise, social networks and social support. Next, Cox's proportional hazards model was used to calculate the hazard ratio (HR) of incident functional disability over 4 years. Respondents who were lost to follow-up by moving or death without incident functional disability, were included as censored data in the models. Regression analysis was performed with simultaneous forced entry of age, sex, annual equivalent

Table 1. Combination of frequency of exercise and participation in a sport organization.

		Sport organization	
		Participation	Non-participation
Exercise	Once a month or more	Active Participant (AP)	Exercise Alone (EA)
	Less than once a month	Passive Participant (PP)	Sedentary (S)

doi:10.1371/journal.pone.0051061.t001

Table 2. Baseline characteristics.

		Active Participant (AP)	Exercise Alone (EA)	Passive Participant (PP)	Sedentary (S)	p
N		1,888	2,548	447	6,698	–
Age (years)	Mean6 SD	70.76 4.9	71.86 5.5	70.76 5.0	73.56 6.6	, .001
		%				
Sex (%)	Males	52.2	57.1	55.7	45.0	, .001
Frequency of exercise (%)	Almost everyday	28.1	57.1	0.0	0.0	, .001
	Twice or three times a week	44.5	28.4	0.0	0.0	
	Once a week	27.3	14.6	0.0	0.0	
	Once or twice a month	0.0	0.0	31.3	2.6	
	Several times a year	0.0	0.0	3.8	1.1	
	Never	0.0	0.0	64.9	96.3	
Frequency of meeting friends (%)	Once a month or more	93.3	75.5	87.0	65.7	, .001
	Less than once a month	5.7	23.0	10.5	30.4	
	Missing	1.0	1.5	2.5	4.0	
Receiving emotional support (%)	Yes	90.3	86.8	86.8	82.9	, .001
	No	6.5	8.9	9.8	10.7	
	Missing	3.2	4.3	3.4	6.4	
Providing emotional support (%)	Yes	86.3	81.6	83.4	73.8	, .001
	No	9.7	13.6	12.3	18.3	
	Missing	4.0	4.8	4.3	7.9	
Receiving instrumental support (%)	Yes	94.0	91.1	92.6	88.9	, .001
	No	3.8	5.4	4.5	5.8	
	Missing	2.2	3.5	2.9	5.3	
Providing instrumental support (%)	Yes	92.5	90.0	92.2	83.5	, .001
	No	3.8	5.7	4.3	9.1	
	Missing	3.7	4.2	3.6	7.3	

*P-value was calculated using one-way analysis of variance (ANOVA) for age.
*P-values were calculated using x^2 test for sex, frequency of frequency of exercise of meeting friends, receiving emotional support, providing emotional support, receiving instrumental support, and providing instrumental support.
doi:10.1371/journal.pone.0051061.t002

income, educational attainment, marital status, occupational status, self-reported medical conditions, depression, smoking and alcohol consumption as covariates (Model 1).

To test which aspect of participation in a sports organization accounts for the prevention of incident functional disability, we added one social network/ support measure to each model from Model 2 to Model 6 and inspected the change in the HR estimate associated with sports participation. Thus, in Mode1 2 for example, we added the variable "frequency of meeting friends" (as a measure of social network) above and beyond the variables in Model 1. In a similar manner, we added the following additional variables in subsequent models: receiving emotional support in Model 3, providing emotional support in Model 4, receiving instrumental support in Model 5, and providing instrumental support in Model 6.

All variables except for age were set as dummy variables. A "missing" category was used in analysis to account for missing values in response to questions regarding the covariates. SPSS 18.0J was used for statistical analysis with a significance level of 5%.

Results

Table 2 shows baseline characteristics. A total of 4,436 subjects exercised once or more a week (38.3%) and 2,335 subjects (20.2%) participated in a sports organization.

There were 1,888 subjects (16.3%) in the Active Participant (AP) group, 2,548 subjects (22.0%) in the Exercise Alone (EA) group, 447 subjects (3.9%) in the Passive Participant (PP) group and 6,698 subjects (57.8%) in the Sedentary (S) group. Mean age was lowest in the AP group and highest in the S group,

with a difference of 2.8 years. The proportion of males was below 50% only in the S group. Regarding frequency of exercise, nearly twice the people in the EA group exercised "almost every day" compared to the AP group. Also, more than ten times more people in the PP group exercised "once or twice a month" compared to the S group. The ratio of subjects who met friends once a month or more decreased in order of AP, PP, EA and S, showing a trend for greater frequency of meeting friends by those who participated in a sports organization. Social support showed the same pattern as frequency of meeting friends, with the ratio of subjects who said they have social support decreasing in order of AP, PP, EA and S for all aspects of support except for receiving emotional support. However, the difference between groups was smaller than that for frequency of meeting friends.

Among the 11,581 subjects analyzed, 909 people died (331 people developed an incident functional disability before they died), 1,380 people developed an incident functional disability and 128 people moved out of the research area during the 4 year follow-up period. The incident rate of functional disability was calculated by dividing the person-years of observation from the number of people who developed an incident functional disability (Table 3). Incident rate was lowest in the AP group, followed by the PP group, the EA group and the S group, in increasing order. The same trend was seen when the data was stratified by age.

Table 4 shows the results of analyzing incident functional disability by performance of exercise and participation in a sports organization using Cox's proportional hazards model. Setting the "Exerciser" group as the reference, the HR for the "Inactive" group was significantly high at 1.26 (95% confidence intervals: 1.10–1.45). Setting the "Participant" group as the reference, the HR for the "Non-participant" group was also significantly high at 1.33 (1.09–1.62).

Table 5 shows the results of analyzing incident functional disability by the 4 groups of different combinations of performance of exercise and participation in a sports organization using Cox's proportional hazards model. Setting the AP group as the reference, the HR for the EA group was significantly high at 1.29 (1.02–1.64) and was even higher for the S group at 1.65 (1.33–2.04). No significant difference was seen in the PP group, with an HR of only 1.16 (0.76–1.77). As it is likely that subjects who responded that they participated in a sports organization but that they "Never" exercised also hardly ever participated in their sports organization, we then conducted sub-analysis with these subjects in the "S" group. The number of subjects in the PP group dropped from 447 people to 157 people, but the HR only changed from 1.16 (0.76–1.77) to 1.15 (0.56–2.37) and the lack of a difference between the PP group and the AP group was therefore maintained.

Next, social networks and social support were used to test which aspect of participation in a sports organization accounts for the prevention of incident functional disability (Table 6). As mentioned above, frequency of meeting friends was then added to the covariates in Model 1 as a measure of social networks. The HR for the EA group dropped slightly from 1.29 (1.02–1.64) to 1.27 (1.00–1.61), and significance disappeared. The HR for the S group was also somewhat attenuated from 1.65(1.33–2.04) to 1.60(1.29–1.98), but the 95% confidence intervals overlapped, and we cannot say that these estimates are statistically different. Addition of either measure of social support resulted in almost no change in the HR for the EA group and the S group.

Table 4. Adjusted hazard ratios (95% confidence intervals) for incident functional disability by exercise and participation in a sport organization.

	N	Crude HR (95% CI)	Adjusted HR (95% CI)
Exerciser	4,436	1.00	1.00[a)]
Inactive	7,145	2.13(1.88–2.42)	1.26(1.10–1.45)
Participant	2,335	1.00	1.00[b)]
Non-participant	9,246	2.64(2.20–3.17)	1.33(1.09–1.62)

[a)]Adjusted for age, sex, annual equivalent income, educational attainment, marital status, occupation status, self-reported medical conditions, depression, smoking, alcohol consumption, and participation in a sport organization.
[b)]Adjusted for age, sex, annual equivalent income, educational attainment, marital status, occupation status, self-reported medical conditions, depression, smoking, alcohol consumption, and exercise.
doi:10.1371/journal.pone.0051061.t004

Discussion

In the present study, we tested incident functional disability by performance of exercise and participation in a sports organization.

Table 3. Incident rate of functional disability for 4 years.

		Active Participant (AP)	Exercise Alone (EA)	Passive Participant (PP)	Sedentary (S)
	Age(years)				
N (%)	65–74	1,503(79.6)	1,815(71.2)	340(76.1)	3,681(55.0)
	75+	385(20.4)	733(28.8)	107(23.9)	3,017(45.0)
	total	1,888(100.0)	2,548(100.0)	447(100.0)	6,698(100.0)
Incident /Person year	65–74	39/6423	77/7850	10/1491	201/16776
	75+	61/845	148/1661	18/228	826/7145
	total	100/7268	225/9511	28/1719	1027/23921
Incident rate	65–74	0.006	0.010	0.007	0.012
	75+	0.072	0.089	0.079	0.116
	total	0.014	0.024	0.016	0.047

doi:10.1371/journal.pone.0051061.t003