名についても運動群では98.2cmから95.9cmへと平均2.3cmの有意な（$p=0.007$）改善が認められた．また血管内皮機能も2.13から2.45へと改善傾向にあった．高コレステロール血症者９名の総コレステロール値は237mg/dlから228mg/dl へと有意に（$p=0.019$）低下した．一方コントロール群ではいずれも有意な変化は示されなかった．BMI や血圧については運動群でも有意な改善は認められなかった．しかし，ステップ運動を週14単位以上実施した人だけを取り上げれば，体重減少が認められ（図１），高血圧であった者は全員に収縮期，拡張期ともに血圧低下が認められた（表４）．

考　察

国民の疾病構造の変化により糖尿病，高血圧，高脂血症等の生活習慣病が問題となっている．このような病態の基礎病態としてメタボリックシンドロームという疾患概念が提唱され[3]その後わが国でも診断基準が示された[4]．これは内臓脂肪肥満を重要視したもので，ウエスト周囲径が男性85cm以上，女性90cm以上（内臓脂肪面積が100cm^{2}以上）のある人で中性脂肪150mg/dl 以上かつ/または HDL コレステロール40mg/dl 未満，収縮期血圧130mmHg 以上かつ/または拡張期血圧85mmHg 以上，空腹時血糖110mg/dl 以上の内２つ以上満たすものと定義された．メタボリックシンドロームに該当する人の頻度は一般人口の10－25％であり，これらの人は運動や食事などの生活習慣を改善する必要があるとされており，特に運動の重要性が注目されている．高脂血症ガイド2004年版[5]では運動療法は動脈硬化性疾患やメタボリックシンドロームの予防・治療効果があり，HDL コレステロールの増加，トリグリセリドの減少，インスリン感受性を改善するだけでなく，ストレス解消や骨密度を高め，Quality of Life を改善すると示されている．そして運動の種類としては大腿筋や大臀筋など大きな筋肉をダイナミックに動かす有酸素運動が推奨されており，運動強度としては50％最大酸素摂取量付近の運動が効果と安全性から適しているとされている．運動時間と頻度としては10～20分以上連続して運動を行い，１日30分以上の運動を毎日続けることが望ましいとされ，最低週３回以上，合計で180分/週以上が目標として掲げられている．また高血圧のガイドライン2004[6]によると，一般に運動をする人は血圧が低いとされており，ここでも運動の種類は有酸素運動（50％最大酸素摂取量）が推奨されている．運動量は１日30分以上とされているが，軽症高血圧では比較的少ない運動量で降圧効果を認める報告もあり，運動を続けると10週間で50％は収縮期血圧20mmHg 以上，拡張期血圧で10mmHg 以上の降圧効果（平均降圧11/6mmHg）と記載されている．今回の試験では運動群全体でみると血圧の低下に有意差は認められなかったが，これは運動

表４　運動実施者（14単位以上）の８週後の血圧変化

収縮期血圧	運動前	運動後	低下率（％）
（mmHg）	150	123	18.0
	156	141	9.5
	133	122	8.3
	153	130	15.0
拡張期血圧	運動前	運動後	低下率（％）
（mmHg）	85	80	7.0
	93	83	10.8
	91	75	17.6

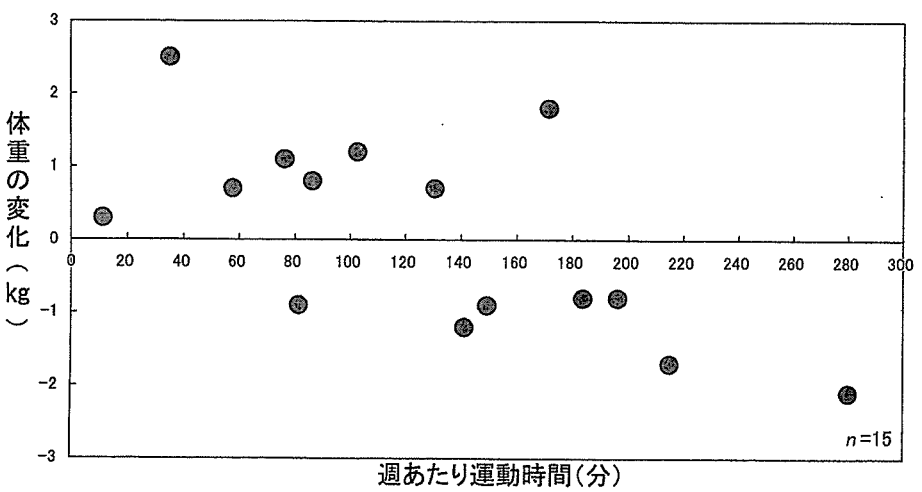

図１　１日の運動時間と体重変化

量の平均が週に11.3単位と少なかったためであろう．実際に週14単位以上の運動を行った者は全員に収縮期，拡張期とも降圧効果が認められ４人中３人の血圧が正常となり，十分な運動量が確保できれば８週間のステップ運動で良好な血圧コントロールが得られる可能性が高いと考えられる．

有酸素能力，即ち一般に全身持久力といわれるものは最大酸素摂取量で評価され，その50％に相当する強度でのトレーニングが，高脂血症などの生活習慣病の改善に効果的であると報告されている[7]．疲労物質とも指摘されている乳酸はある運動強度までは，ほとんど蓄積が認められず，最大酸素摂取量の50％あたりから指数関数的に急増する．乳酸が急増し始める強度は乳酸閾値（LT）とよばれ，LT以下の強度の運動であれば息切れを起こすことなく余裕を持って運動を継続することが出来る．実際にマラソンの平均スピードは一流選手から市民ランナーまで LT に近似していることが示されている[8]．Motoyama[9)10)]らは LT 強度でのウォーキングにより，血圧やHDLコレステロールが有意に改善したと報告している．通常最大酸素摂取量の測定には自転車エルゴメーターやトレッドミルなどの高額な機械や特殊な技術が必要である．また一度に測定できる人数にも限りがあり，健診受信者や地域住民を対象とした運動処方として一般化することは容易ではない．一方LTはAyabe[1)]らの開発したステップテストによる判定法で安価に且つ簡便に測定可能であるため，今回の研究ではこの方法を用いて運動処方を行った．

身体活動量の単位として MET が知られている．METは運動時酸素摂取量/安静時酸素摂取量として表され，安静時の酸素摂取量（3.5ml/分/kg）が１METであり，健康づくりのための身体活動量の基準値としては23METs・時/週（運動強度が３METs以上の活動で１日当たり約60分．歩行中心の活動であれば１日当たり，およそ8,000－10,000歩に相当），また運動量の基準値としては４METs・時/週（速足で約60分，ジョギングやテニスで約35分）とされている[11]．しかし，一般的には身体能力の多い人は体力が高く，また体力を高めるための運動強度には下限があるため[12]，これらの漠然とした数値の運動処方では不十分で，個々人の体力に合わせた最も効率的な運動強度と時間による具体的な推奨運動処方が望まれる．ステップ運動はステップ台を昇り降りする単純な運動で，台の高さと１分間の昇降回数を変えることで容易に運動強度を変えることができる．台高20cmでのステップ運動は昇降頻度60，80，100，120回/分はそれぞれおよそ４，５，６，７METsに相当する[13]．

今回我々の試験結果でステップ台を用いたステップ運動が最も効率的な運動処方の一つであることが示された．すなわち乳酸閾値を測定することで決定された台高と昇降頻度で１回10分，１日３回のトレーニングを指示することで，食事制限を指示しなくても，腹囲や総コレステロール値の有意な低下を示した．実際には指示された運動量を実施できない例も多かったにも係らず運動群全体でみたこれらの指標の変化は，本運動方法の呼びかけの有用性を示している．また週14単位（１日平均20分の運動）以上のトレーニングを実施した者については，この他に体重の減少や血圧の低下が認められた．このことから今回のステップ運動の推奨量は，この運動強度で１日２単位以上と考えられる．14単位以上の運動群で１人のみ体重増加した例があったが，これは試験期間中の他の作業で肉離れをおこし運動の継続が２週間途切れ，その間食事量が増加したとの自己申告があった．このことは運動の継続性の重要性を示唆するものと考えられる．

血管内皮機能は血管の拡がりやすさを表す指標で，血管の内面を覆っている血管内皮細胞という一層の細胞の機能を表す．これらの内皮による血管拡張反応も高血圧や加齢，糖尿病などで障害され動脈硬化が促進されるとされている[14]．今回の血管内皮機能の測定では運動群において血管内皮機能は改善傾向にあったが，この正常値は1.67以上とされており，運動群では測定値が上昇して弾力性のある血管になっている可能性があるが，正常値の範囲の変化であり，現状では評価は困難で今後の研究の進展を見ていく必要があると思われる．

今回の我々の検討では対象者が少なく，今後も対象者数を増やして検討する必要があるが，ステップ運動は自宅で手軽に行える運動であり，器具も安価で，天候の影響も受けず，時間の制約も少ない．また手軽に水分補給や休憩もとれ安全に実施できる．自宅でテレビを見ながら他人の目も気にせず実行できるという利点もある．単調な運動であり実施の継続が懸念されるが，体重の減量効果が現れれば運動を継続するモチベーションは高まるものと考えられる．本試験に参加を呼びかけた67人中実際の参加者は33名（49.3％）でその中で週14単位以上の運動実施者は41.2％であった．すなわち生活習慣の改善の必要な人に本運動を呼びかければ約20％が週14回の運動を行う可能性があり，その効果は今回示された通りで

ある．単純にこの数値が実行されれば，かなりの人たちの病院受診や薬物投与が不要になる可能性がある．医療費に占める生活習慣病の割合は，わが国では平成15年度で10.2兆円に上り，国民医療費の約3割を占めている．本運動プログラムを呼びかけ，普及させることにより，国民の健康増進そして増大する医療費の削減が期待される．

本研究においては運動療法単独での効果をみるため敢えて食事指導は行わなかったが，生活習慣病の予防・改善のためには食事療法も重要であり，実地では食事療法も併せて指導することでより大きな効果が得られると思われる．

まとめ

乳酸閾値で決定した運動強度を用いたステップ運動の有効性を示した．自宅でも手軽に行える本運動プログラムは生活習慣病の予防・改善に有効であり，このプログラムの呼びかけにより国民健康の増進と医療費削減が期待できる．

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An Exercise Program for Prevention and/or Improvement of Lifestyle Related Disease: A Randomized Controlled Trial Using a Bench Step Exercise

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Abstract

Objective: For the prevention or improvement of lifestyle related disease an 8-week exercise program involving a bench step exercise was arranged. Methods: Thirty-three employees who had been recommended to change their lifestyle following a routine health check were enrolled. Before and after the program, their physical performance was evaluated, and their waistline, total cholesterol value and blood pressure was recorded and compared. There were no dietary restrictions. The 33 subjects were randomly divided into two groups: an exercise group and a control group. The exercise group was instructed to execute a bench-stepping exercise over ten consecutive minutes three times a day (i.e. twenty-one times a week) at a bench height and stepping rate that varied depending on each individual's lactate threshold as determined by an exercise stress test. Results: Only 11.8% of the participants completed the step exercise program as planned (21 times/week), but 42.2% executed it 14 or more times a week. These participants showed not only an improved physical performance, but experienced a significant reduction in weight, waistline size and total cholesterol value. Furthermore, the blood pressure of those participants suffering from hypertension was lowered. Conclusion: The step exercise over 8 weeks at the lactate intensity threshold leads to a significant reduction in waistline, total cholesterol value and blood pressure. We recommend executing the step exercise at the lactate intensity threshold more than twice a day (i.e. 14 or more times/week).

Key words : lifestyle related disease, bench step exercise, randomized control trial

（資料）1. 健康づくりのための運動基準2006-身体活動・運動・体力-　英語訳

2. 同　韓国語訳

3. 健康づくりのための運動指針2006（エクササイズガイド2006）　韓国語訳

4. 同　中国語訳

5. 新しい運動基準・運動指針普及定着ガイドブック

厚生労働科学研究費補助金 「健康づくりのための運動指針」に関する研究-身体活動量増加による生活習慣病の一次予防効果-」
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「健康づくりのための運動基準2006」

Exercise and Physical Activity Reference Quantity for Health Promotion 2006

Physical Activity, Exercise, and Physical Fitness

Outline

Prepared August, 2006

By the Office for Lifestyle-Related Disease Control,

General Affairs Division, Health Service Bureau,

Ministry of Health, Labour and Welfare of Japan

We re-examined the recommended quantity of exercise for health promotion (1989) and set reference values for the quantity of physical activity and exercise for Japanese between the ages of 20 and 69 years. Specifically, for individuals who intend to promote health mainly through physical activity, a daily walk of 8,000 to 10,000 steps is set as the target. For those who rely on exercise for health promotion, the target was set at 35 min of jogging or playing tennis or one hour of brisk walking every week.

1. This report, which concerns the quantity of physical activity and exercise for health promotion, specifically for preventing life-style related diseases, is promulgated by the "Committee for the Determination of the Recommended Exercise Allowance and Exercise Guide" that was established on August 8, 2005. The basis for the report was the "Recommended Quantity of Exercise for Health Promotion" compiled in 1989, utilizing the latest scientific findings.

"Recommended Quantity of Exercise for Health Promotion" compiled in 1989, utilizing the latest scientific findings.

2. The content of this report differs markedly from the Recommended Quantity of Exercise for Health Promotion that was set in 1989 with the emphasis placed on the prevention of lifestyle-related diseases. Some of the outstanding features in the report are: (1) both domestic and overseas publications were thoroughly examined (systematic review) and the references for the quantity of physical activity, exercise and physical fitness (maximal oxygen uptake) are indicated; and (2) the relationship between the prevention of lifestyle-related diseases and physical fitness (including muscle strength) is also evaluated.

3. Reference values for the quantity of physical activity and exercise for health promotion

   (1) Quantity of physical activity: 23 MET·hours/week

   (Equivalent of an activity with an intensity of 3 METs or more lasting for about 60 min per day. If the activity is composed mainly of walking, the quantity is equivalent to 8,000 to 10,000 steps per day)

   (2) Quantity of exercise: 4 MET·hours/week

   (e.g., 60 min of fast walking or 35 min of jogging or playing tennis)

4. Reference values for the maximal oxygen uptake for health promotion by gender and age levels ($mL \cdot kg^{-1} \cdot min^{-1}$)

Gender/Age	20s	30s	40s	50s	60s
Males	40	38	37	34	33
Females	33	32	31	29	28

5. This report incorporates the latest scientific findings concerning the relationship between health and physical activities and physical fitness. To amass new findings that may

emerge later, including findings on questions that have not been elucidated, it is necessary to continue studies, acquire new scientific findings and periodically update this report.

Exercise and Physical Activity Reference Quantity for Health Promotion 2006

(EPARQ2006)

—Physical Activity, Exercise, and Physical Fitness—

A Report

Committee for the Determination of the Recommended Exercise Allowance and Exercise Guide

2006

1. Introduction

As an all-out approach to formulate a national policy for health promotion, the First National Program for Health Promotion was issued in 1978. The Second National Program for a Health Promotion was introduced in 1988; and in 2000, a "campaign for health promotion in the 21st century (Healthy Japan 21)" was established. As a legislative backup for the positive health promotion and the prevention of diseases in citizens, with special reference to "Healthy Japan 21," a Health Promotion Law was formulated in 2002 and the campaign for health promotion has been well on its way since then.

In view of the global trends for health promotion, "Healthy Japan 21" purports to achieve objectives such as extending one's healthy life expectancy: specifically, topics were selected that relate to improving one's lifestyle affecting the development and progression of lifestyle-related diseases (e.g., cancer, heart diseases, stroke and diabetes mellitus). Some 70 specific numerical objectives in 9 areas were listed—"nutrition and food habits," "physical activities and exercise," "rest and mental health," "smoking," "alcohol drinking," "dental health," "diabetes mellitus," "circulatory diseases" and "cancer." Currently, efforts are being made to promote health in these areas.

For the starting point in promoting health through physical activities and exercise, the committee, based on scientific findings, established the "Recommended Quantity of Exercise for Health Promoion" in 1989 as a target for the quantity of exercise considered necessary to maintain one's health. To create a happy, active and healthy life, in 1993, the "Exercise Guideline for Health Promotion" was published. This was followed in 1997 by a report from the "Committee to Study Physical Activities for Health throughout One's Life."

With rapid aging of the population in recent years, morbidity patterns have changed: the proportion of lifestyle-related diseases (e.g., cancer, ischemic heart disease, cerebrovascular diseases and diabetes mellitus) to total morbidity increased. Among the causes of death, about 60% was attributed to lifestyle-related diseases (cancer, 30.5%; ischemic heart diseases, 15.7%; cerebrovascular diseases, 13.0%; diabetes mellitus, 1.3%; and hypertensive diseases, 0.6%). In fiscal 2003, the medical cost for these diseases amounted to 10.2 trillion (2.8 trillion each for hypertensive diseases and cancers; 2.0 for cerebrovascular diseases; 1.9 for diabetes mellitus including its complications; and 800 billion for ischemic heart diseases). Within the framework of health insurance, the total amounts to about 30% of the medical expenditures for the whole nation, indicating the burden of these diseases place on people. As these diseases increase in severity, the burden on national nursing insurance will also increase.

In May 2004, at a conference attended by the Secretary General of the Ruling Parties and Chairman of the Policy Research Council, "A Strategy for the Health Frontier" was formulated. In response to this development, the Government adopted the following as central themes for its policies to extend one's expectancy of a healthy life by about 2 years: 1) "plan to assure health during the productive years," 2) "urgent anti-cancer policy for women," 3) "a 10-year strategy for nursing and disease prevention," and 4) "promotion of scientific technology to extend expectancy of healthy life." Starting in 2005, active programs are being and will be developed over the succeeding 10 years.

2. Process leading to the establishment of the policies described above

The "Recommended Quantity of Exercise for Health Promotion (1989)" was formulated mainly to prevent coronary artery diseases. With the passage of more than 15 years following the establishment of this standard, the morbidity pattern of people changed, in which lifestyle-related

diseases—such as diabetes mellitus, hypertension and dislipidemia—come to the forefront. In April 2005, the disease concept and diagnostic standard for "metabolic syndrome," the basis for the aforementioned conditions, were explicated at the related 8 academic societies.[1]

Metabolic syndrome is a pathophysiologic condition manifested by hyperglycemia, dyslipidemia and hypertension, all of which share a common etiology: a visceral-type obesity. When these disease conditions overlap, the risk for developing ischemic heart diseases and cerebrovascular disorders increases; therefore the basic rationale concerning this metabolic syndrome is that such a risk may be reduced when the visceral fat is minimized.

By promoting the policies to control lifestyle-related diseases, incorporating this concept related to the metabolic syndrome, in particular by encouraging people to engage in physical activities and exercise and improving their understanding and also that of personnel concerned with public health of the importance of "prevention," it is believed that the current policies may be effectively carried out.

According to the "National Health and Nutrition Survey in Japan, 2004," the proportion of those who were regularly exercising was 30.9% for men and 25.8% for women since determination of the Recommended Quantity of Exercise for Health Promotion in 1989. In spite of the efforts represented by "Healthy Japan 21," these percentages failed to increase, showing that two-thirds of the population did not have the habit of exercising regularly.

While the public is becoming increasingly more aware of the policies concerning lifestyle-related diseases, the Section on the Regional Health, Promotion of Health and Nutrition of the Public Welfare Science Council formulated "The Promotion of Future Policies concerning Lifestyle-Related Diseases (an interim report). Thus under a slogan of "first, exercise and

physical activity; second, diet; third, smoking cessation; and last, medication," further emphasis was placed on policies for physical activities and exercise.

Facing this situation, it was decided to draw up the "Recommended Quantity of Exercise for Health Promotion (1989)" to show the references for physical activity, exercise and physical fitness. These references, based on the latest scientific findings, were designed to maintain and promote the health of people and prevent lifestyle-related diseases through improving their capacities for physical activity and exercise.

3. Approaches for establishing criteria

With the rapid aging of the population over the last few decades, morbidity patterns have changed drastically: the proportions occupied by lifestyle-diseases, such as cancer, ischemic heart diseases, cerebrovascular diseases and diabetes mellitus, to the total morbidity have increased. For the causes of death also, lifestyle-related diseases are implicated in about 60%. When these lifestyle-related diseases become more advanced many patients require nursing care.

In both domestic and foreign studies it has been suggested that there is a relationship between the prevention of lifestyle-related diseases and physical activities and exercise. Promoting people's physical activities and exercise will produce a notably positive effect on the prevention of lifestyle-related diseases.

The "Exercise and Physical Activity Reference Quantity for Health Promotion 2006" (defined herein) is designed to prevent lifestyle-related diseases and contribute to a state of positive health.

Relationship among the prevention of lifestyle-related diseases, physical activities, exercise and physical fitness

Scientific studies on physical activities, exercise, lifestyle-related diseases, and total mortality have rapidly advanced during the last quarter of a century: the preventive effects of physical activities and exercise—not only on coronary artery diseases but also on lifestyle-related diseases, such as diabetes mellitus—have been scientifically proven. Ever since the establishment of the recommended quantity of exercise for the first time (1989) in particular, a considerable amount of evidence has been amassed on the prevention of lifestyle-related diseases through physical activities and exercise. Therefore for the current "Exercise and Physical Activity Reference Quantity for Health Promotion," it was decided to conduct a systematic review based on the accumulated evidence and to indicate the quantity of physical activity and exercise that is necessary to prevent lifestyle-related diseases.

In general, the level of physical fitness is higher in a person who engages in physical activities to a large extent.[2-4] However, there is a lower limit in the exercise intensity to heighten physical fitness,[5] and the correlation between the quantity of physical activity that is quantified by the total energy expenditure (kcal/day) and physical fitness is not necessarily evident.[6] Especially, a large quantity of physical activity of low intensity is not always associated with notable physical fitness.[7] There is also significant genetic influence on physical fitness.[8] According to recent studies conducted in the west, not only the quantity of physical activity but also physical fitness act as independent factors to predict the development of a lifestyle-related disease.[9] Therefore in the "Exercise and Physical Activity Reference Quantity for Health Promotion 2006" it was decided that a reference for physical fitness be independently defined, in addition to those for physical activities and exercise.

Standardization of Terminology

Definitions of the terminology related to physical activities and exercise described in this report are given in the section of reference materials.

4. Physical activities and exercise that are necessary to maintain and improve health

A systematic review of the domestic and foreign literature was conducted on the relationship between physical activities and exercise and lifestyle-related diseases to define the reference that is given below. In this instance, separate references were selected for physical activity and exercise, both intensities being over 3 metabolic equivalents (METs).

The ages of the subjects were assumed to be in a range of 20 to 69 years. The references were set for the uniform quantity of physical activity and exercise (MET·hours/w) regardless of the gender or age.

Quantity of physical activity

For physical activity, the reference was set at 23 MET·hours/w.

The results from the systematic review indicated that the lower threshold of physical activity that is effective in preventing lifestyle-related diseases is distributed between 19 and 26 MET·hours/w. The time for physical activity per week equivalent to this value is between 54 and 74 min per day at an intensity of 3 METs (walking at normal pace). However for an ordinary person, it is not easy to determine the time corresponding to 3 METs; nor is it possible to discern the latitude of 20 min. Thus for a reference for the quantity of physical activity, a single value—the mean of the values extracted from the systematic review—was used.

People are expected to exceed this reference, depending on one's current level of physical activity. In this manner, it is hoped that the risk of developing a lifestyle-related disease will be reduced.

Physical activities that exceed 3 METs for intensity include exercise and non-exercise activity, for example, walking (such as shopping and commuting), cleaning floors, yard work, carrying objects, and playing with children. Because the intensity of activities represented by walking at normal pace is around 3 METs, 23 MET·hours/w ($\fallingdotseq$3.3 MET·hours/d) is the equivalent of about 60 min per day for physical activity at an intensity of about 3 METs. This physical activity is not necessarily limited to walking but most activities at this intensity are normally accompanied by walking. Therefore, if one considers the activity is composed mainly of walking, the time is equivalent to about 60 min per day (about 6,000 steps if one takes 1,000 steps every 10 min). In daily activities, one takes 2,000 to 4,000 steps at low intensity without being conscious of exercising [10] and the total number of steps one takes per day probably amounts to 8,000 to 10,000 steps.

Quantity of exercise

The reference quantity for exercise and its range are 4 MEs·hours/w and 2 to 10 MET·hours/w.

These are based on the corresponding figures of the exercise reference that ranged about 2 to 10 MET·hours/w and the mean, 4 MET·hours/w, according to the systematic review. Depending on the current exercise level, a person should set his target above the reference or its range. For example, a person who has no habit of exercising is to set the goal at 2 MET·hours/w; one whose customary level of exercise is below the reference value should raise the quantity to

the reference; and for a person whose quantity of exercise exceeds the reference should aim at 10 MET·hours/w. In this manner, it is expected that the risk for developing a lifestyle-related disease will be reduced.

Specific examples of exercises at intensities being 3 METs and more include brisk walking, physical exercises (with active movements), jogging, running, swimming and ball games. For example, brisk walking is associated with an intensity of about 4 METs (90 to 100m per min). Thus 4 MET·hours/w is converted to brisk walking of about 60 min per week. Similarly, jogging or playing tennis (about 7 METs) is the equivalent of about 35 min/wk.

5. Physical fitness essential to maintaining and promoting health

A systematic review was conducted on domestic and foreign literature dealing with the relationship between physical fitness and lifestyle-related diseases. For physical fitness, a reference was set for maximal oxygen uptake, an index for endurance, as shown below. As for muscular strength, the basis for setting a quantitative reference was lacking so a qualitative description was used instead.

Maximal oxygen uptake

A systematic review was conducted on the domestic and foreign literature to find the relationship between maximal oxygen uptake and lifestyle-related diseases. Based on the data thus obtained, the references for maximum oxygen intake and its range, which were stratified for each gender and age group (from the 20s to 69 years, see below), were set. The systematic review provided us with several of the lowest values for the maximal oxygen uptake, with significantly different risks for developing a lifestyle-related disease. It was considered appropriate to set the reference value for maximal oxygen uptake to prevent a lifestyle-related

disease for each gender and age category. The mean was computed from these values to define the reference for maximal oxygen uptake for health promotion.

Table 1. Reference values for the maximal oxygen uptake for health promotion by gender and age levels ($mL \cdot kg^{-1} \cdot min^{-1}$)

Gender/Age	20s	30s	40s	50s	60s
Males	40	38	37	34	33
Females	33	32	31	29	28

In addition to the reference values, the current study exhibits a range for the maximal oxygen uptake required for health promotion. This range is one in which the lowest values of the maximal oxygen uptake by which the effect to prevent lifestyle-related diseases is noted in the systematic review; and it is a range of values in at least one study in which the effect of the maximal oxygen intake to prevent lifestyle-related diseases is evident. Therefore if the maximal oxygen uptake is below this range, one should aim to raise it within the level. If the maximal oxygen uptake is below the reference, one should be reminded to aim for this reference. Even when one's maximal oxygen uptake is higher than the reference or the range shown in the table (below), one should try to make certain that lifestyle-related diseases will be effectively prevented by improving his physical fitness.

Table 2. Range of maximal oxygen uptake that is effective for health promotion ($mL \cdot kg^{-1} \cdot min^{-1}$)

Gender/Age	20s	30s	40s	50s	60s
Males	23-47	31-45	30-45	26-45	25-41
Females	27-38	27-36	26-33	26-32	26-30

Muscular strength

On the relationship between muscular strength and reductions all cause mortality, several studies indicated that muscle strength is inversely related to overall risk for death among men;

but this relationship was frequently absent among women. However, in all the studies in which both men and women were evaluated as a single group, muscular strength was inversely related to the overall risk of death.

There are several methods for measuring muscular strength; but regardless of the method adopted, the all-cause mortality is significantly reduced in each group because of the presence of those whose muscular strength exceeds the mean of that group. To prevent osteoporosis and fractures also, it is important to maintain a certain level of muscular strength.

Muscular strength and muscle volume decrease with age. Reductions in the overall mortality or the risk of fractures due to osteoporosis have been noted in those exceeding the average of these data in each group that was studied. Although based on qualitative data only, maintenance of muscular strength over the current mean can be a yardstick for the modern Japanese in each generation.

Other parameters for physical fitness

It has been known that the risk for fractures due to osteoporosis is reduced in those who maintain their equilibrium or are nimble. However, there were no studies that focused on reductions in mortality or the prevention of lifestyle-related diseases. Therefore no quantitative reference was set for other parameters related to physical fitness.

6. Notes on applying these references

Sufficient care should be taken because excessive or inappropriate exercise may have adverse effects on one's health. When a person already suffers from a certain illness but plans to engage in exercise, the exercise program should be conducted under the guidance of a physician.

7. Future objectives and directions

In carrying out physical activities and exercise according to the "Exercise and Physical Activity Quantity for Health Promotion 2006", it is necessary that the results are evaluated after a certain period; and that the references are periodically revised, taking into consideration of the results of evaluations and those of new studies.

Based on the current study, the following are considered necessary for future research:

- Accumulation of evidence concerning physical activity, exercise, and physical fitness (including muscular strength and muscle volume) of Japanese and the prevention of lifestyle-related diseases.
- Standardization of methods for evaluating physical activity
- Evaluation of physical activity, exercise and physical fitness for each gender, age level (ranging from childhood to advanced age) and specified life-related diseases
- Evaluation of specific references for muscular strength and muscle volume
- Evaluation of the upper threshold of physical activity and exercise for health promotion
- Determination of the effect of moderating medical expenses that becomes possible when one engages in physical activity and exercise