Table 1. Precision (CV %) of hs-CRP in 1st and 2nd internal quality controls by 9 laboratories

Laboratory No	Precision (CV %)		p value between 1st and 2nd QC
	1st QC	2nd QC	
1	2.8%	3.7%	0.65
2	1.8%	0.9%	0.66
3	4.2%	3.6%	0.69
4	2.5%	1.9%	0.68
5	1.6%	1.4%	0.70
6	1.5%	1.0%	0.70
7	2.0%	1.9%	0.71
8	2.4%	1.6%	0.69
9	0.6%	1.4%	0.69
Average	2.2%	1.9%	0.77

QC, quality control.
Average is the mean CV value of 9 laboratories.

1st test was distributed from a minimum of 0.6% to a maximum of 4.2%, and the mean CV of the 9 analytical laboratories was 2.2%. Similarly, the CV of the 2nd test was distributed from 0.9% to 3.7%, and the mean CV was 1.9%. The mean CV of the sum of the 1st and 2nd tests was 2.0%. There was no significant difference by Student's t-test in the CV of internal QC between the 1st and 2nd tests by individual analytical laboratories (p =0.65-0.71) and by all 9 analytical laboratories (p =0.77).

The precision of individual analytical laboratories calculated from all measured values of the 3 tests of external QC was 2.4% for laboratory 1, 2.2% for laboratory 4, 2.4% for laboratory 5 and 3.6% for laboratory 9. When the precision of external QC over a long period of 3 years was investigated, the CV was distributed from a minimum of 2.2% to a maximum of 3.6%, and the mean CV of the 4 analytical laboratories was 2.7%. There was no significant difference by one-factor ANOVA in the CV among the 3 tests of external QC by the 4 analytical laboratories (p =0.36-0.58).

Accuracy

The initial test of external QC: The mean value of the 1st test of the external QC by the individual analytical laboratories is shown in **Table 2**. The accuracy of sample 1 ranged from a minimum of −6.0% to a maximum of 6.4%, that of sample 2 from −4.2% to 5.3%, that of sample 3 from −4.0% to 4.9%, that of sample 4 from −5.3% to 4.0%, and that of sample 5 from −8.3% to 3.9%. Based on these findings, the acceptable range of accuracy was established within ±10% of the mean value as the consensus value.

The second test of external QC: The accuracy of the 2nd test of the external QC by individual analytical laboratories is shown in **Table 3**. The accuracy of sample 1 ranged from a minimum of −4.2% to a maximum of 6.8%, that of sample 2 from −3.3% to 5.2%, that of sample 3 from −3.5% to 4.1%, that of sample 4 from −3.3% to 4.7%, and that of sample 5 from −4.2% to 7.3%. All analytical laboratories satisfied the established acceptable range, within ±10% of the consensus value. The mean accuracies of samples 1-5 of the 9 analytical laboratories and the mean accuracy of all samples are presented in **Table 3**.

The third test of external QC: The accuracy of the 3rd test of the external QC of the individual analytical laboratories is shown in **Table 4**. The accuracy of sample 1 ranged from a minimum of −2.3% to a maximum of 6.2%, that of sample 2 from −2.4% to 1.9%, that of sample 3 from −4.7% to 7.0%, that of sample 4 from −4.6% to 7.9%, and that of sample 5 from −5.5% to 9.3%. All analytical laboratories were within the established acceptable range. The mean accuracies of samples 1-5 of the 4 analytical laboratories and the mean accuracy of all samples are shown in **Table 4**.

Discussion

Previous studies documented the precise relationship between hs-CRP levels and the risk of cardiovascular events[1, 2, 4]. Several large-scale prospective studies demonstrated that hs-CRP is a strong independent predictor of future myocardial infarction and stroke among apparently healthy men and women in Western populations[4, 10, 11], but this is unconfirmed in Japanese general populations because hs-CRP levels vary

Table 2. Consensus value of hs-CRP in 1st external quality control by 9 laboratories

Laboratory No	Mean value of hs-CRP (%bias vs consensus value)				
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1	53.8 (1.5%)	97.4 (−1.0%)	265.5 (−3.2%)	294.0 (−2.7%)	419.1 (−0.2%)
2	56.4 (6.4%)	101.4 (3.0%)	268.5 (−2.1%)	297.9 (−1.4%)	421.4 (0.4%)
3	52.7 (−0.6%)	96.5 (−1.9%)	272.0 (−0.8%)	301.7 (−0.1%)	424.7 (1.1%)
4	51.6 (−2.6%)	97.2 (−1.2%)	263.3 (−4.0%)	286.2 (−5.3%)	385.2 (−8.3%)
5	49.8 (−6.0%)	94.9 (−3.6%)	280.2 (2.2%)	309.8 (2.5%)	436.3 (3.9%)
6	50.6 (−4.5%)	94.3 (−4.2%)	270.1 (−1.5%)	297.3 (−1.6%)	418.5 (−0.3%)
7	54.6 (3.0%)	103.6 (5.3%)	287.5 (4.9%)	314.2 (4.0%)	418.8 (−0.3%)
8	52.8 (−0.4%)	97.0 (−1.4%)	276.3 (0.8%)	304.4 (0.8%)	432.9 (3.1%)
9	55.0 (3.8%)	102.9 (4.6%)	284.8 (3.9%)	313.0 (3.6%)	422.1 (0.5%)
Mean value as consensus	53.0	98.4	274.2	302.1	419.9
Acceptable range	47.7-58.3	88.6-108.2	246.8-301.6	271.9-332.3	377.9-461.9
SD of mean value	2.15	3.42	8.50	9.28	14.47
CV of sample	4.1%	3.5%	3.1%	3.1%	3.4%

unit: μg/dL

Table 3. Accuracy of hs-CRP in 2nd external quality control by 9 laboratories

Laboratory No	Mean value of hs-CRP (%bias vs consensus value)					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Mean of %bias
1	56.6 (6.8%)	103.5 (5.2%)	276.0 (0.7%)	307.1 (1.7%)	424.8 (1.2%)	3.12%
2	55.1 (4.0%)	100.7 (2.3%)	267.1 (−2.6%)	295.1 (−2.3%)	414.5 (−1.3%)	0.02%
3	53.6 (1.1%)	99.6 (1.2%)	284.9 (3.9%)	316.2 (4.7%)	450.7 (7.3%)	3.64%
4	50.8 (−4.2%)	95.2 (−3.3%)	271.6 (−0.9%)	300.4 (−0.6%)	420.2 (0.1%)	−1.78%
5	51.0 (−3.8%)	98.1 (−0.3%)	285.5 (4.1%)	313.8 (3.9%)	447.3 (6.5%)	2.08%
6	52.4 (−1.1%)	97.0 (−1.4%)	271.6 (−0.9%)	303.0 (0.3%)	420.7 (0.2%)	−0.58%
7	56.3 (6.2%)	103.2 (4.9%)	275.1 (0.3%)	305.0 (1.0%)	413.4 (−1.5%)	2.18%
8	53.2 (0.4%)	98.7 (0.3%)	269.6 (−1.7%)	293.6 (−2.8%)	413.5 (−1.5%)	−1.06%
9	51.8 (−2.3%)	96.7 (−1.7%)	264.7 (−3.5%)	292.2 (−3.3%)	402.3 (−4.2%)	−3.00%
Mean value	53.4	99.2	274.0	302.9	423.0	
Mean of %bias	0.79%	0.80%	−0.07%	0.29%	0.76%	0.51%
SD of mean value	2.17	2.86	7.26	8.56	16.04	
CV of sample	4.1%	2.9%	2.6%	2.8%	3.8%	

unit: μg/dL

Table 4. Accuracy of hs-CRP in 3rd external quality control by 4 laboratories

Laboratory No	Mean value of hs-CRP (%bias vs consensus value)					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Mean of %bias
1	56.3 (6.2%)	100.3 (1.9%)	269.0 (−1.9%)	296.3 (−1.9%)	410.0 (−2.4%)	0.38%
4	51.8 (−2.3%)	96.0 (−2.4%)	261.2 (−4.7%)	288.3 (−4.6%)	398.9 (−5.0%)	−3.80%
5	52.8 (−0.4%)	97.7 (−0.7%)	293.3 (7.0%)	325.9 (7.9%)	459.1 (9.3%)	4.62%
9	52.3 (−1.3%)	96.6 (−1.8%)	271.2 (−1.1%)	290.9 (−3.7%)	396.7 (−5.5%)	−2.68%
Mean value	53.3	97.7	273.7	300.4	416.2	
Mean of %bias	0.55%	−0.75%	−0.18%	−0.58%	−0.90%	−0.37%
SD of mean value	2.04	1.90	13.77	17.36	29.20	
CV of sample	3.8%	1.9%	5.1%	5.8%	7.0%	

unit: μg/dL

remarkably by race and ethnic group[12-14]. The low level of hs-CRP in Japanese is approximately one third of the median value in Caucasians[15]. It is currently under investigation that hs-CRP is a predictive marker for cardiovascular events in Japan and hs-CRP levels in Japanese are positively associated with body mass index, systolic and diastolic blood pressure, triglycerides, and fasting glucose, and negatively with HDL-cholesterol[15].

It is well known that measurements of CRP have traditionally been used to diagnose and monitor acute-phase inflammation, but CRP assays have had high detection limits of 500 μg/dL or more in the acute reactant range[10, 11, 16]. Recently, chronic inflammation has been clarified as an important factor in the development and progression of atherosclerosis, and CRP has been found to be an inflammatory marker of cardiovascular risk[17, 18], similar to serum amyloid A, white blood cell count, fibrinogen, etc[4]. The concentrations of CRP measured to assess chronic inflammation in atherosclerosis are significantly lower than in acute inflammation; therefore, hs-CRP assays were developed with detection limits of lower than 10 μg/dL and the ability to measure CRP in a range below the detection limit of conventional assays. Rifai and Ridker[17] proposed that medical decision points established by prospective epidemiologic studies be used to interpret individual patient CRP results in risk assessment for cardiovascular disease. This is similar to the approach used by the National Cholesterol Education Program for blood lipids[19] and requires that assays be standardized so that they provide comparable results[20]; however, evidence of inflammation is lacking between hs-CRP and cardiovascular diseases in Japanese people. Therefore, to accomplish this goal, a long-term external quality control program for hs-CRP was needed.

The external QC program for hs-CRP was designed based on the practicality of plasma protein measurement. Saitoh *et al.* reported factors that vary the measured values of immunochemical assays based on principles of antigen-antibody reactions as follows: (1) reference value assignment method, (2) differences in the matrix between reference and patient samples, (3) differences in antibodies used as reagents (monoclonal/polyclonal antibodies, immunized animals, and immunogen), (4) differences in the measurement principle (SRID method, nephelometry, turbidimetry), and (5) differences in analytical instruments and parameters[8]. The measurement systems used in laboratory testing comprise a heterogeneous system, combining these factors[21]. The establishment of a homogeneous system for analytical laboratories by standardizing all factors is impractical, and this is the same for the standardization of lipid measurement[21, 22]. To overcome this problem, it is practical to incorporate common reference material and to standardize the measurement conditions as much as possible. Kimberly *et al.* reported that unification of the reference alone does not solve variation among analytical laboratories, and varying measurement values are unavoidable due to measurement conditions, such as antibodies, measurement principles, and analytical instruments[6, 8].

The gold standard of references for protein measurement is purified protein. Preparation of purified protein is generally technically easy, but no definitive or reference method is available for hs-CRP to assign reference values for the gold standard, primary and secondary materials, or measure the serum component[6]. Thus, we considered that it is most appropriate to adopt a method in which multiple analytical laboratories measure hs-CRP using reliable measurement systems that satisfy the basic performance criteria, taking the gold standard or primary reference material as the common standard, and the mean of the measured values as the consensus value[6, 8, 21, 22].

We established the consensus value as the target from outlier-processed measured values of the initial test analyzed by the 9 laboratories. They all calibrated the instrument using N CRP serum standardized with CRM 470 of the international plasma protein reference material[8], because there are no globally accepted criteria for accuracy assessment[6]. These target values are the consensus values applied to our study as well as other studies commonly using sera for external QC. We started the external QC by setting the acceptable accuracy range of means obtained by individual analytical laboratories to within ±10% of the consensus value. It was also prescribed that, when a mean deviated by ±15% or more from the consensus value, the analytical laboratory was required to revise the procedure. However, no analytical laboratory required such revision, to which the maximal unification of the measurement conditions, such as measurement instruments, reagents, and serum for calibration, may have contributed.

For precision, hs-CRP within a concentration range of 30-1,000 μg/dL, CV <10% is targeted in the AHA/CDC Scientific Statement, and the present study adopted this specification[1]. The CV in this study well satisfied the AHA/CDC assessment criterion in both internal QC and external QC. These findings suggest that CV <5% is applicable as the acceptable precision rather than CV <10%. Since no major deviation was noted in the CV between internal and external QC, it was concluded that variations in internal QC were well reflected in external QC. Approval of the basic performance for hs-CRP reagents required by the US Food and Drug Administration (FDA) is 3% or lower CV at an hs-CRP concentration around 100 μg/dL. The consensus value of sample 2 in the initial external QC was set to 98.4 μg/dL (**Table 2**). For example, the average CV of the concentration of sample 2 was 2.4% and 2.6% in the 1st and 2nd internal QC, respectively (not presented in the table), and 3.5%, 2.9%, and 1.9% in the 1st, 2nd and 3rd external QC, respectively (**Table 2-4**). As a result, they were similar to the FDA requirement.

For accuracy, **Table 3** suggests that the consensus values and their acceptable ranges set by the initial test of the external QC were valid. Similarly, **Table 4** suggests that the consensus values and their acceptable ranges were also valid, and the hs-CRP value was stable at least through the three-year follow-up period stored at −70°C.

In the clinical chemistry field, many study results of hs-CRP performance have been reported, but they are almost all experimental data tested in a laboratory. There have been few reports of long-term results obtained from collaborative epidemiological studies or clinical trials in which multiple analytical laboratories actually participated. A 6-month follow-up of measured values has been reported[18], but no previous study followed variations in hs-CRP values through a three-year follow-up period using an external QC program applied to epidemiological study or clinical trials; therefore, this study is significant in this regard.

In conclusion, we presented an external QC program of hs-CRP for three years in a collaborative epidemiological study and showed the precision and accuracy of hs-CRP.

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メタボリック健診における LDL コレステロールの測定精度の科学的根拠は十分か？

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【目的】特定健診と基本健診の健診項目では、総コレステロール(以下総コと略)は廃止、LDL コレステロール(以下Ｌコと略)が新規追加された。総コに代わり得るほど、Ｌコの測定精度の科学的根拠は十分だろうか？CDC/CRMLN の認証試験を背景に分析側から考察した。【方法】大阪府立健康科学センター脂質基準分析室は、米国の CDC による脂質標準化のネットワーク(CRMLN)に登録するわが国唯一の基準分析室である。世界中の試薬企業や臨床検査室に対する認証資格を持つ。2006 年秋、Ｌコの試薬発売企業６社を対象に標準化を実施した。総コとＬコの測定精度の科学的根拠として、認証試験の結果から見たときの(1) 正確度 (2) 精密度 (3) 総合誤差 (4) 認証合格率 (5) 認証試験における同一検体の測定値の最大濃度差 (6) 乖離の問題 (7) 基準測定法と標準物質の有無 (8) 米国のＬコの測定現状、などの比較基準を設定し数量比較した。【結果】(1) 正確度は総コが 1.0%であったが、Ｌコは 3.7%。Ｌコは総コの 3.7 倍も正確度が不良。(2) 精密度(CV)は総コが 0.8%であったが、Ｌコは1.0%、大差はなかった。(3) 総合誤差では、総コが2.6%であったが、Ｌコは5.7%。Ｌコは総コの2.2倍の誤差を有する。(4) 試薬メーカーに対する認証合格率では、総コは 100%であるが、Ｌコでは 92%。Ｌコの試薬の採否に注意を要する。(5)+(6) 測定値の最大濃度差は、総コでは僅かに5 mg/dL に過ぎなかったが、Ｌコでは9.8倍の 49 mg/dL にまで拡大。Ｌコ値で大きな施設間差が避けられない。Ｌコの乖離報告は続出するが、総コでは皆無。(7) Ｌコの基準分析法も標準物質も確立されていない。後者の開発の見通しは明るくない。この現状で全国的施策として実施してよいのか？(8) 米国の危険因子に関するSurvey では、Ｌコの直接法は正式採用されていない。【考察】米国の NCEP で見ると、総合誤差の判定基準は総コが8.9%、Ｌコは 12%に設定され、Ｌコの測定が難しいことは認識されている。しかし、総コとＬコの測定精度を、8 項目の基準で比較すれば、精密度を除いて、Ｌコが総コよりも優れているというエビデンスは得られない。換言すれば、Ｌコに切り替えた場合、測定精度は総コよりも悪化し、測定値の信頼性が損なわれる可能性を否定できない。平成 20 年度からＬコを導入する際の現状把握と施策評価の為のデーター整備が不十分ではないか？わが国が先進諸国に先行して、総コを廃し、Ｌコを健診に早期導入することを、分析サイドから懸念する。

日本の動向

「健康日本21」の中間評価——栄養・食生活分野を中心に

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●「健康日本21」策定の趣旨・目的

近年，わが国において生活習慣病は依然として主要な死亡要因であり，少子高齢化が急速に進む中，医療費や介護の負担の増加が危惧されている。このような現状を踏まえ，すべての国民が健やかで心豊かに生活できる活力ある社会とするため，2000年3月，厚生労働省によって第三次国民健康づくり運動として「21世紀における国民健康づくり運動（健康日本21）」が策定された。

「健康日本21」では，壮年期死亡の減少，健康寿命の延伸，ならびにQOL（生活の質）の向上を理念に掲げ，生活習慣の改善等に関する課題について目標値が設定されている。そして国民一人ひとりの健康づくりに関する意識を向上させ，主体的に取り組めるよう，健康に関係する団体等にも提言し，社会全体で取り組む運動となっている。これは，1978年の栄養・運動・休養を推進した第一次国民健康づくり対策，1988年の運動習慣に重点をおいた「アクティブ80ヘルスプラン」よりも，なおいっそう，"一次予防"に重点をおいた運動であり，2001年からの10カ年計画として実施されている。

●「健康日本21」の全般的な動向

2002年に「健康日本21」を中心とする健康づくり施策を推進する健康増進法が制定され，都道府県・市町村において健康増進計画の策定が同法に規定された。「健康日本21」の最終ゴールを実現するために，1）一次予防の重視，2）健康づくり支援のための環境整備，3）目標等の設定と評価，4）多様な実施主体による連携の取れた効果的な運動の推進，の4点を基本方針として開始された。

これら基本方針に基づき，9つの重点分野について，達成すべき70項目の目標が設定された。9つの重点分野とは，①栄養・食生活，②身体活動・運動，③休養・こころの健康づくり，④たばこ，⑤アルコール，⑥歯の健康，⑦糖尿病，⑧循環器病，⑨がん，である。これらは大きく，生活習慣に関連した分野（①～⑥）と，二次予防など疾病と直接的に関連した分野（⑦～⑨）によって構成される。

さらに健康増進法においては，それ以前の栄養改善法に基づく国民栄養調査が国民健康・栄養調査として内容の拡充が図られ，「健康日本21」の経過モニタリングの役割が明示された。また，受動喫煙の防止措置を講ずる努力義務が規定された。さらに国民の健康寿命の延伸を基本目標とした，「生活習慣病予防対策の推進」と「介護予防の推進」を柱とする2005年度からの10カ年戦略（健康フロンティア戦略）が策定された。

2008年度からはメタボリックシンドローム（内臓脂肪症候群）の克服に重点を置き，ハイリスクアプローチを主体とした「特定健診・保健指導」が開始され，よりいっそう「健康日本21」を推進し，生活習慣病を克服する基盤が形づくられてきている。

●「栄養・食生活」分野の動向

栄養・食生活分野は多くの生活習慣病やQOLと関連が深く，健康およびQOLの向上を図るため身体的・精神的・社会的に良好な食生活の実現を目標としている。個人の行動変容およびそれを支援する環境の確保について，具体的に14項目の目標設定が行われた。

この目標を踏まえて，①国民健康・栄養調査の実施や「食事摂取基準」の策定など科学的根拠の蓄積および整理，②「食生活指針」や「食事バランスガイド」などの普及啓発や食環境整備，③豊かな人間性を育むための食育を総合的・計画的に推進することを目的とした，「食育推進基本計画」の策定，④管理栄養士等の人材育成およびボランティア（食生活改善推進員等）の育成などが取り組まれている。

0918-2675/07/¥30/頁/JCLS〔栄レ 60 号 PP.69-74〕

●中間評価の目的と経緯

「健康日本21」の中間評価の目的は，目標の設定と目標を達成するための具体的な活動の成果を適切に評価するとともに，健康づくり対策の推進に必要な情報を得て，今後の対策に反映させることである。特に，目標の達成状況や達成状況と関連する促進・阻害要因等を探ることにより，「健康日本21」を改善するにあたっての課題を明らかにすることが大きな目的となっている。

そこで2005～2006年に国および都道府県において，「健康日本21」開始から5年経過時点での中間評価として，9分野70項目の指標の中間実績値の分析，各分野の評価，未設定数値目標の設定，代表目標項目の選定，新規目標項目の設定等について検討が行われた。また，各分野の施策の評価については，指標の動向のまとめ，現在の取組み，その取組みの問題点と今後の施策のあり方等について検討が行われた。

●中間評価の概要

国における全般的な評価の要点を以下にまとめる。

① 数値目標の導入により，これまでさまざまな調査で把握されていた国民の健康指標に関する各種データが，国民健康・栄養調査等で把握されるようになり，体系的・継続的なモニタリングや評価が可能となった。

② すべての都道府県で都道府県計画が策定され，平成18年7月時点では全1,859市町村のうち1,001の市町村（約54%）において計画が策定された。

③ 中間実績値からは，脳卒中，虚血性心疾患の年齢調整死亡率の改善傾向がみられ，脂肪エネルギー比率や女性の肥満者の増加に歯止めがかかった。一方，高血圧，糖尿病などの生活習慣病は特に中高年男性で改善されず，男性の肥満者の割合や日常生活における歩数のように，悪化している項目がみられた。全体としては，必ずしも十分ではない点がみられた。

「栄養・食生活」領域における目標とその達成状況を表1に示した。全14項目のうち，経年的な比較に注意が必要な項目は5項目，新たに目標値を設定した項目は4項目であった。また改善傾向にある項目は8項目であり，改善傾向がみられていない項目は5項目，中間実績値がない項目は1項目であった（表1）。本稿では特に，国民一人ひとりが意識を向上させることで，改善することができると考えられる「栄養状態，栄養素（食物）摂取レベル」および「知識・態度・行動レベル」の指標について解説を行う。

●「栄養状態レベルの指標」に対する評価

エネルギーの摂取過剰については，消費とのバランスで評価する必要があるが，そのバランスが反映された栄養状態として過体重（肥満）を指標とし，現状と目標値が示されている。

「適性体重を維持している人の増加」では，児童・生徒（小児）について，日比式による標準体重20%以上の肥満児の割合は，ベースライン値10.7%，中間実績値10.2%とほぼ変化がなかった（表1-1.1）。一方，成人ではBMI≧25の肥満者が，40～60歳代女性でベースライン値25.2%，中間実績値24.6%と減少しているが，20～60歳代男性ではベースライン値24.3%，中間実績値29.0%と増加していた（表1）。これは1997年と2004年の2時点における調査データの比較であり，経年的変化を踏まえると，小児では1976～1990年までは増加傾向が顕著であったが，その後は横ばい傾向であり，40～60歳代女性でも横ばい傾向にあった。2時点での比較で増加していた20～60歳代男性の肥満者の割合の毎年の変化を図1に示した。1976～1999年の25年間では肥満者の増加がどの年齢階層においても顕著であったが，「健康日本21」が開始された2000年以降は，特に若年層を中心として増加の速度が小さくなる，または横ばいとなっている。

このようなことから，小児，成人，また男女ともに，「健康日本21」が開始された2000年以降，肥満者の割合は以前のようには増えていないものと考えられる。

●「栄養素・食品摂取量レベルの指標」に対する評価

栄養・食生活と関係の深い生活習慣病には，高血圧，高脂血症，虚血性心疾患，脳卒中，がん，糖尿病，骨粗鬆症などがある。これらの疾病と食事との関連については，エネルギーの過剰摂取，脂肪，ナトリウムの過剰摂取，食物繊維・抗酸化ビタミン・カルシウムの摂取不足があげられる。このため，目標値として，適正体重を維持する者の増加，児童・生徒の肥満の減少，成人の脂肪エネルギー比率の減少，成人の食塩摂取量の減少，野菜の摂取量の増加，カルシウムに富む食品摂取量の増加など，具体的な目標値が示された。

本稿では，日本人における重要な健康問題のひとつである高血圧のリスクに関連する食塩の摂取量と，生活習慣病予防の視点から特にメタボリックシンドローム対策において重要項目となっている野菜の摂取量に着目し，具体的なデータをみながら解説を加えたい。

食塩については，高血圧予防の観点から，諸外国では6g以下が推奨され，日本では10g未満が推奨されている。1997年においては，成人1日当たり平均摂取量は13.5gと依然として過剰な状況にあったことから，

表1.「栄養・食生活」領域における目標とその達成状況（中間評価，2006）

目標項目（指標の目安）	対象	ベースライン値	中間実績値	目標値
適正な栄養素（食物）の摂取について（栄養状態，栄養素（食物）摂取レベル）				
1.1 適正体重を維持している人の増加（肥満者等の割合）	児童・生徒の肥満児	10.7%	10.2%	7%以下
	20歳代女性のやせの者	23.3%	21.4%	15%以下
	20〜60歳代男性の肥満者	24.3%	29.0%	15%以下
	40〜60歳代女性の肥満者	25.2%	24.6%	20%以下
1.2 脂肪エネルギー比率の減少（1日当たりの平均摂取比率）	20〜40歳代	27.1%/日	26.7%/日	25%以下
1.3 食塩摂取量の減少（1日当たりの平均摂取量）	成人	13.5g/日	11.2g/日	10g 未満
1.4 野菜の摂取量の増加（1日当たりの平均摂取量）	成人	292g/日	267g/日**	350g 以上
1.5 カルシウムに富む食品の摂取量の増加（成人）（1日当たりの平均摂取量）	牛乳・乳製品	107g/日	101g/日**	130g 以上
	豆類	76g/日	65g/日**	100g 以上
	緑黄色野菜	98g/日	89g/日**	120g 以上
適正な栄養素（食物）を摂取するための行動変容について（知識・態度・行動レベル）				
1.6 自分の適正体重を認識し，体重コントロールを実践する人の増加（実践する人の割合）	男性（15歳以上）	62.6%	60.2%	90%以上
	女性（15歳以上）	80.1%	70.3%	90%以上
1.7 朝食を欠食する人の減少（欠食する人の割合）	中学生，高校生	6.0%	6.2%	0%
	男性（20歳代）	32.9%	34.3%	15%以下
	男性（30歳代）	20.5%	25.9%	15%以下
1.8 量，質ともに，きちんとした食事をする人の増加（1日最低1食，きちんとした食事を，家族など2人以上で楽しく，30分以上かけてとる人の割合）	成人	56.3%*	61.0%	70%以上
1.9 外食や食品を購入する時に栄養成分表示を参考にする人の増加（参考にする人の割合）	男性（20〜69歳）	20.1%	18.0%	30%以上
	女性（20〜69歳）	41.0%	40.4%	55%以上
1.10 自分の適正体重を維持することのできる食事量を理解している人の増加	成人男性	65.6%*	69.1%	80%以上
	成人女性	73.0%*	75.0%	80%以上
1.11 自分の食生活に問題があると思う人のうち，食生活の改善意欲のある人の増加（改善意欲のある人の割合）	成人男性	55.6%	59.1%	80%以上
	成人女性	67.7%	67.3%	80%以上
適正な栄養素（食物）を摂取するための個人の行動変容に係る環境づくりについて（環境レベル）				
1.12 ヘルシーメニューの提供の増加と利用の促進（提供数，利用する人の割合）	男性（20〜59歳）	34.4%	—	50%以上
	女性（20〜59歳）	43.0%	—	50%以上
1.13 学習の場の増加と参加の促進（学習の場の数，学習に参加する人の割合）	男性（20歳以上）	6.1%	7.4%	10%以上
	女性（20歳以上）	14.7%	15.3%	30%以上
1.14 学習や活動の自主グループの増加	男性（20歳以上）	2.4%	3.5%	5%以上
	女性（20歳以上）	7.8%	7.4%	15%以上

*：策定時のベースライン値を把握した調査と中間実績値を把握した調査とが異なっている数値。
**：食品成分表の改訂に伴った重量変化率の換算等が必要な数値。

集団平均として10g 未満が目標とされた。一方，2005年に策定された「日本人の食事摂取基準」によれば，ナトリウム摂取「目標量」（DG）は，食塩相当量として成人男性で10g 未満，成人女性で8g 未満となっている。これは個人における目標値であるため，「健康日本21」のように集団に対する目標としては，平均摂取量10g 未満がそのまま用いられている。

「食塩摂取量の減少」では，1997年のベースライン値が13.5g，2004年の中間実績値で11.2gと2.3g減少していた（表1-1.3）。しかしこの食塩の摂取量は，2001年に食品成分表が改訂されたこと等の影響もあることから，データ比較には十分な注意が必要である。図2に成人における食塩の摂取量の経年変化を示した。食品成分表や調査方法の変更などを考慮して経年推移

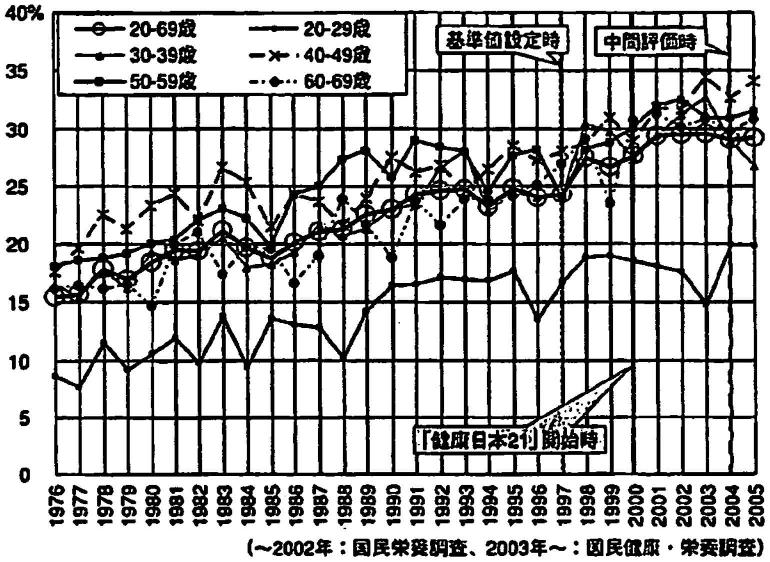

図1．肥満者（BMI≧25）の割合の年次推移（成人男性）
※：40歳以上の年齢階級においては，2006年の公表データも示した。

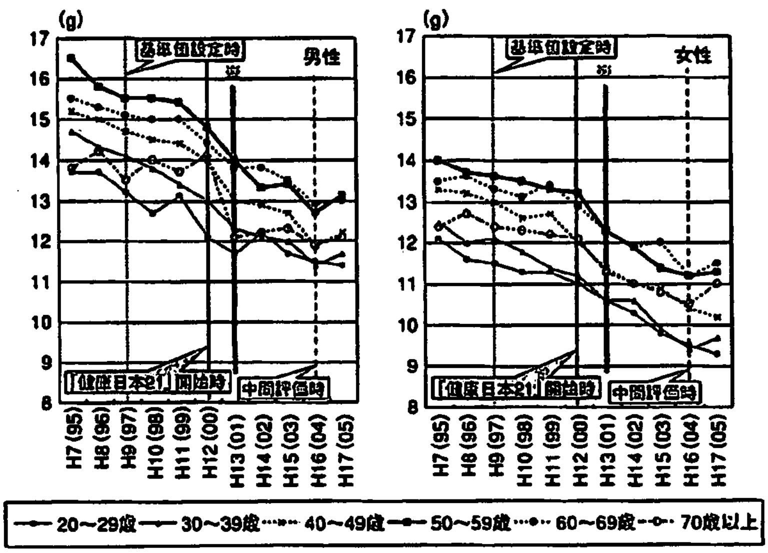

図2．食塩摂取量の年次推移（性・年齢階級別）
※：食品成分表の切替え。

をみると，どの性・年齢階層においても減少傾向にあり，特に生活習慣病のリスクの高い50歳代男性における減少傾向が顕著であった（図2）ことはたいへん好ましいことである。このように改善がみられたのは，住民に対して直接，保健サービスを提供する地方自治体や，健康づくりに関連する事業を行う各種団体の活動など，地域の「食育」や健康教育の成果であるかもしれない。しかし今後，食塩摂取量の評価（個人レベル・集団レベル）のために，食品成分表に記載されていない加工食品等について，成分値のデータベースを整備し，それを個人に対する栄養指導および外食等の成分表示に有効に活用していく等，さらなる対策が必要と考えられる。

カリウム，食物繊維，抗酸化ビタミンなどの摂取は，循環器疾患やがんの予防に効果的に働くと考えられており，これらの栄養素摂取量と食品摂取量との関連を分析すると，野菜の摂取の寄与が大きい。そしてカリウム，食物繊維，ビタミンC等の栄養素を十分に摂るためには，野菜350〜400gの摂取が必要とされることから，成人において平均350g以上が目標とされた。

「野菜の摂取量の増加」では，1997年のベースライン値292gと比較して，2004年の中間実績値は267gとむしろ減少していた（表1-1.4）。図3に成人における野菜の摂取量の経年変化を示した。1997年以降2003年までは，成人全体でみるとほぼ横ばいの傾向である。しかし2003年と2004年を比較すると，どの性・年齢階層においても約20g程度摂取量が減少していた。これは，2004年11月に台風などの気象の影響で，農作物の生産量が下がり，生鮮野菜の価格が例年よりも高騰したためであると考えられる。翌2005年の摂取量は以前のレベルまで戻っていることから，2004年の低値が一時的な現象であったと推察される。また世代間に大きな差がみられ，比較的摂取量の多い60歳代と比較して，20歳代の摂取量は平均して約70gも低い。相対的に摂取

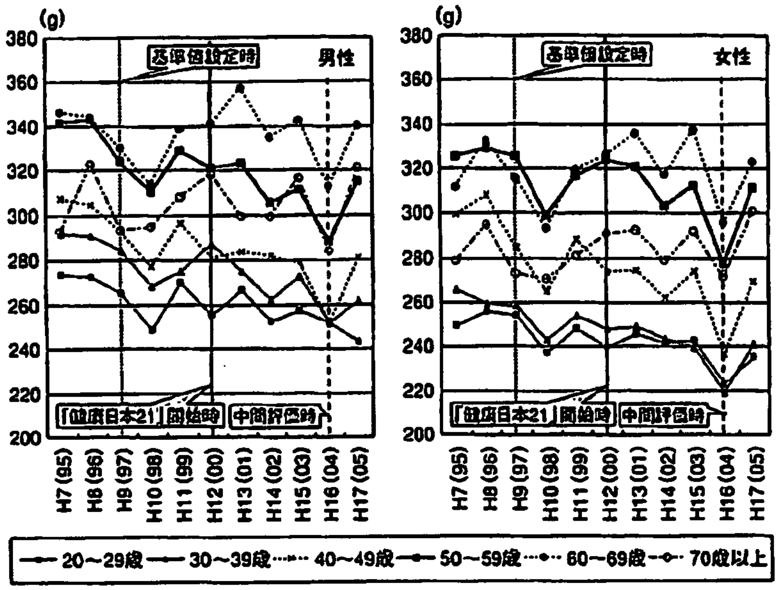

図3．野菜摂取量の年次推移（性・年齢階級別）

量の少ない30歳代までの若年層では特に摂取増加が望まれるが，そのような増加傾向はみられていない（図3）。

以上のことから，野菜の摂取量には価格の影響が大きく，世代間の差も大きいことから，食環境の面からの対策が重要であると考えられる。すなわち，野菜の価格を低価格かつ一定に保つなどの取組みや，「食事バランスガイド」の普及・啓発，食生活への関心が少ない層や野菜の摂取量の少ない層に対する，外食やコンビニエンスストア等の場での働きかけなどが今後重点的に行うべきとことと考えられる。

●「知識・態度・行動レベルの指標」に対する評価

栄養状態，栄養素摂取の改善を図るためには，個々人の知識・態度・行動をいかに変容させるかが重要である。

具体的な目標として，自分の適正体重を知り，体重をコントロールする人の割合の増加，20～30歳代の朝食欠食率の減少，外食や食品を購入する際の栄養成分表示の活用，自分の適正体重を保つための食事量を理解している人の増加，自分の食生活に問題があると思う人における改善意欲の向上などがあげられた。

行動レベルとしては，肥満者の割合を減少させるためには，各人が適切な体重コントロールを行うことが必要となる。「自分の適正体重を認識し，体重コントロールを実践する人の増加」では，1998年において15歳以上の男性で62.6%，女性で80.1%であることから90%以上にすることが目標とされ，2004年の中間実績値では，男性60.2%，女性70.3%であった（表1-1.6）。1998年と2004年の2時点における調査データの比較にすぎず詳細な変化の状況は不明だが，男性は横ばい，女性は減少傾向にあった（表1）。相対的に男性においては体重コントロールを実践しようとする人が増加したとも言える。

知識レベルとしては，食事量や内容に関する知識の習得が必要であり，特に適正体重を維持するには，どれだけ食べればよいかを知ることが重要であると考えられた。そこで「自分の適正体重を維持することのできる食事量を理解している人の増加」が目標とされた。1997年のベースライン値では，男性65.6%，女性73.0%が食事量を理解していたのに対し，2004年の中間実績値は，男性69.1%，女性75.0%と若干増加していた（表1-1.10）。特にライフステージの中で肥満傾向に傾きやすい男性の30歳代において，「自分にとって適切な食事内容・量」を知っている人の割合が増えたことは望ましい傾向であると言える。

態度レベルとしては，まず食生活に問題があると思う場合に，改善しようという意識を持つようになることが大切である。1997年で「食生活に問題がある」とする人は成人男性31.6%，女性33.0%であった。このうち改善意欲のある人は男性55.6%，女性で67.7%であり，これらを80%以上にすることが目標とされた。「自分の食生活に問題があると思う人のうち，食生活の改善意欲のある人の増加」は，2004年の中間実績値では男性59.1%，女性67.3%と，男性では増加傾向，女性では横ばいであった（表1-1.11)。食事の自己評価および食事の改善意欲についての割合を性・年齢階級別に，図4に示した。全対象者に対する「食生活に問題があり，かつ改善意欲のある」人の割合をA，「食生活に問題のある」人のうち，「改善意欲のある」人の割合をBとした。女性ではどの年齢階層においても，2004年にはAの割合が増加しているが，Bの割合についてはあまり変化がなかった（図4）。これは食生活に

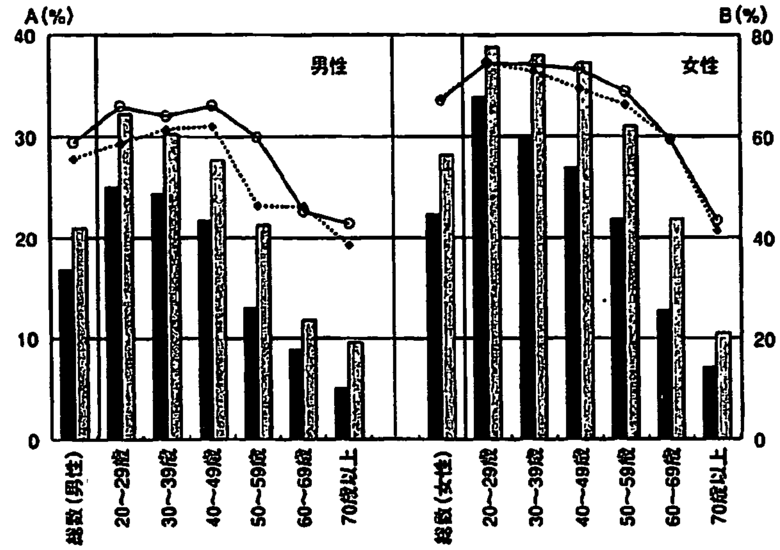

図4．自分の食生活に問題があると思う人のうち，食生活の改善意欲のある人の割合（性・年齢階級別）
A(%)："問題ありかつ改善意欲"／全体（■1996年 ▨2004年）。
B(%)："改善意欲"／"問題あり"（…◆…1996年 —○—2004年）

問題があることは気づいても，改善しようという意欲までは持てていないことが示唆される。また男性も同様に，どの年齢階層においても，Aの割合は2004年に増加しており，Bの割合も増加している。特に50歳代男性において，A・B両方の割合の増加が著しく（図4），食生活に問題があることを認識し，それを改善しようとする意識が高まったのではないかと考えられる。生活習慣病，メタボリックシンドロームの予防・改善という観点から，自らが「改善意欲」を持ち，食事をコントロールすることは，特に20～50歳代の男性に求められることであり，食生活の改善意欲のある人が増加したことは望ましい傾向にあると言える。

●まとめ・今後の課題

本稿では「健康日本21」中間評価の中でも「栄養・食生活」分野で注目すべき項目を取り上げて解説した。取り上げた以外の項目においても，「健康日本21」策定時ベースライン値に比べ，改善傾向のみられない項目がいくつかあり，これまでの進捗状況は全体としては必ずしも十分ではないと評価されている。

今回取り上げた項目では，特にメタボリックシンドロームのリスクの高い中年男性において，実際の「栄養状態レベル」でみると，肥満者の経年的な増加傾向はおさまってきたようであるが，割合としては未だ多い。一方，「知識・態度・行動レベル」でみると自分の適正体重を認識し，コントロールする人の割合が増加するなど，意識・行動に改善傾向がみられているが，実際の食品選択，行動変容までにはまだ結びついていないことが示唆された。

このような現状から，国の施策として，メタボリックシンドロームの概念を導入し，個人の努力を社会全体として支援する健康づくりの国民運動化を図る「ポピュレーションアプローチ」に加えて，2008年度からは特定健診・保健指導を通じ「ハイリスクアプローチ」が強力に行われることとなっており，両アプローチの相乗的な効果が期待される。

また，「健康日本21」の中間評価を受け，さらに医療制度構造改革により，「健康日本21」と「医療費適正化計画」とが，整合性を持ちつつ推進されることが必要となり，「健康日本21」の運動期間を2年延長し，最終評価を2010～2012年度にかけて実施することとなった。

生活習慣病は，遺伝，環境，生活習慣などのさまざまな要因が関連して発症・進行するが，特に食習慣との関連は大きい。食の洋風化・簡便化，外食・加工食品の増加，朝食の欠食，孤食化，さらに過食・偏食などの食生活の変化が，生活習慣病の増加にもつながっていると懸念されている。こうした現状の中で，「健康日本21」の中間評価を受けて，今後は「食事バランスガイド」の普及啓発や効果的な健診・保健指導の実施など，より具体的な取り組みを通じて，国民全体の健康づくりが進んでゆくことが期待される。

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Trends in the prevalence of anaemia in Japanese adult women, 1989–2003

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Abstract

Objective: There is an increasing concern of anaemia in Japanese women, but no national trend data has existed to date. We analysed long-term national trends of anaemia in adult women.
Design: Secondary analyses of 15 consecutive cross-sectional nationwide surveys conducted during the period 1989–2003. Analyses were based on 5-year intervals (1989–1993, 1994–1998, 1999–2003).
Setting: Japan.
Subjects: The subjects included the National Health and Nutrition Survey of Japan (NHNS-J) population. Analyses were based on 50 967 non-pregnant/non-lactating women aged 20 years and over, with complete data sets. We stratified subjects into six age groups (20–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years and 70+ years), and three age groups (20–49 years, 50–69 years, 70+ years) for analyses on residential areas (metropolitan, cities and towns).
Results: Decreases in trends of mean haemoglobin values (intravenous) were significant in all age groups. Changes in the prevalence of anaemia were significant only in women aged 30–39 and 40–49 years. Anaemia (haemoglobin $< 12.0\,g\,dl^{-1}$) increased from 16.8% to 20.6% in women aged 30–39 years, and from 20.2% to 26.9% in women aged 40–49 years, respectively. Prevalence was highest in women aged 70 years and older in all times, but no significant change was observed.
Conclusions: Haemoglobin values have declined significantly in all ages in the last 15 years. Anaemia was especially significant in women aged 30–39 years and 40–49 years. Our findings suggest that a large number of young women in Japan are at risk of anaemia, so continuous monitoring and controlling efforts of this trend are needed.

Keywords
Anaemia
Japan
Women
Trends
Nutrition surveys

In terms of public health, anaemia or iron deficiency anaemia is the most commonly used indicator of iron deficiency[1]. Iron deficiency anaemia may result from one or more of the following: (1) inadequate dietary iron intake or low iron bioavailability; (2) impaired absorption (e.g. gastric surgery, intestinal malabsorption); (3) increased iron needs during growth or during pregnancy; (4) increased iron loss due to heavy menstrual blood loss or chronic disease[2,3]. Common causes of anaemia, other than iron deficiency, include other vitamin deficiencies (e.g. vitamin B_{12}, B_6, folate and C)[4]. Anaemia of chronic disease, a condition accompanied by inflammation, is present in some people, including young children[4].

The consequences of iron deficiency anaemia or iron deficiency are often deleterious. A review of longitudinal studies indicated that children who were anaemic in early childhood continued to have poor cognition and school performance in middle childhood, compared with non-anaemic children[5]. Severe anaemia during pregnancy is strongly related to increased risks of low birth weight, preterm birth and perinatal mortality[6,7]. Iron deficiency, even without anaemia, is also associated with reduced physical performance and work capacity[8].

Anaemia is found in approximately two billion people worldwide, with half of all cases caused by a lack of iron[9]. In 2001, iron deficiency anaemia was found to affect 10.3% of adult women in industrialised countries[10] and, in the United States in 1998, 5% of women aged 20–49 years and 2% of women aged 50 years and older were found to be anaemic[2]. In the United Kingdom, approximately 8%

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of adult women have iron deficiency anaemia and 11% have low iron stores without anaemia, according to data from the 2000–01 National Diet and Nutrition Surveys (NDNS)[11]. There is no comparable national data on iron deficiency or iron deficiency anaemia in Japan, other than studies focusing on specific population groups[12–14]. However, the Japanese Red Cross Blood Centre[15] indicated that the average deferral rate for female donors, due to insufficient blood gravity, increased from 6.4% to 8.4% between 1995 and 2005 nationwide. Although low blood gravity is not specific to anaemia, attempts to verify this issue are needed.

The increasing prevalence of underweight women is a major health problem in Japan[16]. Iron deficiency is uncommon among female patients with anorexia nervosa due to increased iron storage secondary to reduced iron losses from amenorrhoea[17]. However, low body mass index (BMI) was an independent risk factor for 'mild iron deficiency' (serum ferritin $< 20\,\mu g\,l^{-1}$ and haemoglobin $\geq 120\,g\,l^{-1}$) in premenopausal adult women in New Zealand[18]. Therefore, we suspect that the risk of iron deficiency, and of anaemia, may also be high in Japan. Therefore, we performed long-term trend analyses of anaemia using national data. There are consecutive cross-sectional haemoglobin data available for adults, collected between 1989 and 2003. Therefore, we analysed changes in haemoglobin over 15 years, and calculated the prevalence of anaemia using the World Health Organization (WHO) standard[10]. We also evaluated geographical differences in changes in haemoglobin and compared the prevalence of anaemia between three residential area types to determine whether the environment plays a role in anaemia development.

Methods

Description of the data source

The National Health and Nutrition Survey of Japan (NHNS-J) is a series of cross-sectional, nationally representative examination surveys conducted by the Ministry of Health, Labour and Welfare[19]. A two-stage sampling technique was used in the NHNS-J. In the first stage, survey districts for the 'Comprehensive Survey of Living Condition of the People on Health and Welfare' were selected using cluster stratified random sampling technique from districts assigned for the nearest population census, which has been conducted every 5 years since 1920. In the second stage for the NHNS-J sampling, a total of 300 survey districts were randomly selected from survey districts for the 'Comprehensive Survey of Living Condition of the People on Health and Welfare', and 5000 households and a total of 15 000 individuals in selected households were chosen to participate in NHNS-J each year.

NHNS-J consists of three components: (1) physical examination (anthropometric measurements; blood pressure; blood tests; interview on use of medication, smoking status, alcohol intake and exercise; pedometer-measured physical activity level), (2) dietary intake survey (1-day, semi-weighed food record per household) and (3) dietary habits questionnaire. All physical examinations take place at local centres, and a team of physicians, nurses, dietitians and laboratory technicians are in charge of the assessment. Blood samples are collected from subjects aged 20 years and over, and are drawn at least 3 h after the last meal. Since 1989, haemoglobin values have been monitored annually, so we performed in-depth analyses on haemoglobin data collected after 1989.

Laboratory procedures and definition of anaemia

In this study, we evaluated haemoglobin values to determine the prevalence of anaemia. Once intravenous blood is collected, haemoglobin values are determined by an autoanalyser (SE-9000) at a private laboratory commissioned by the government authority. We applied the WHO criteria to define anaemia: haemoglobin concentration of $<12\,g\,dl^{-1}$ for non-pregnant women above 15 years of age[10]. It has been suggested by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC) in the United States[2] that haemoglobin cut-off values should be adjusted for subjects who reside in a high altitude ($\geq$3000 ft) and for those who smoke cigarettes. However, there is insufficient information regarding the effect of smoking on haemoglobin concentrations in the Japanese and what level of adjustment is appropriate, so we used crude haemoglobin concentrations to evaluate the prevalence of anaemia.

Subjects for the current analyses

We conducted secondary analyses of 50 967 non-pregnant/non-lactating women aged over 20 years, who participated in the NHNS-J between 1989 and 2003. Subjects with no data on haemoglobin were excluded from the secondary data set. We obtained permission to use the NHNS-J data sets from the relevant government authority prior to the analyses. In order to avoid year-to-year fluctuations and to have adequate sample sizes for subgroup analyses, data were grouped into three time periods (1989–1993, 1994–1998 and 1999–2003). For subgroup analyses, subjects were divided into six age groups (20–29 years; 30–39 years; 40–49 years; 50–59 years; 60–69 years; and 70+ years). In terms of geographical comparisons, we first divided subjects into three age subgroups (20–49 years; 50–69 years; and 70+ years), and then subdivided into three areas ('metropolitan' – 12 major cities and 23 Tokyo Metropolitan Wards with a population of more than 10 00 000 people; 'cities' – all cities with a population of less than 10 00 000; 'towns' – all small towns and villages). This segmentation allows for a better estimation of which group is at higher risk of anaemia.

Statistics
Haemoglobin concentrations were expressed as means and standard deviations (SD) for each time period according to age groups and residential areas. The prevalence of anaemia (haemoglobin $< 12.0\,g\,dl^{-1}$) was expressed as a percentage (%) for each time period, according to age groups and residential areas.

To evaluate trends in mean haemoglobin levels, we computed regression coefficients for successive survey years using general linear models, coded as 0, 0.2, 0.4, etc., up to 2.8, for 1989, 1990, 1991, etc., up to 2003. The results are shown as the increment of each parameter per 5 years with 95% confidence intervals (CIs). To evaluate trends in the prevalence of anaemia across the three time periods, logistic regression analysis was used and the results are shown as the increment in the odds ratio (OR) with 95% CI (OR for 1989–1993 is 1.00, the reference). For geographical comparisons in the prevalence of anaemia, logistic regression analysis was used to compare values for metropolitan areas and cities with towns within the same age group in each time period. $P < 0.05$ was considered to be statistically significant.

The Hosmer–Lemeshow goodness-of-fit was used to assess goodness-of-fit for all models. P for χ^2 goodness-of-fit >0.30 was considered to be well-fitted for all models. The generalised coefficient of determination statistics, i.e. R^2, was used to describe the proportion of variability explained by the model. If the value of R^2 is close to zero, one variable cannot be predictable from other variable. All statistical analyses were performed using SAS software (Version 8.2).

Results

Table 1 shows changes in mean haemoglobin value in $g\,dl^{-1}$ (with SD) over 15 years, according to the overall and demographic subgroups, i.e. age groups and residential areas. For age groups, the mean haemoglobin values were lowest in subjects aged 40–49 years throughout the three time periods: 12.8 (1.5), 12.6 (1.5) and 12.4 (1.5), respectively. There was a decreasing trend for mean haemoglobin values, with these trends significant in all age groups. In terms of residential areas, statistically significant decreases in mean haemoglobin values were observed in all three areas in all three age subgroups, except for the groups of women aged 70 years and older who resided in metropolitan areas and small towns. The overall change in mean haemoglobin in all subjects aged 20 years and older from 1989 to 2003 was −0.08 (95% CI −0.09, −0.07), and the decline was statistically significant ($P < 0.01$).

Table 2 shows the prevalence of anaemia in each time period by the overall and demographic subgroups (i.e. age groups and residential areas) and the ORs for changes in the prevalence of anaemia from the logistic regression

Table 1 Trends in mean haemoglobin values in women aged 20 years and over, according to age and residential areas: 1989–2003

	1989–1993		1994–1998		1999–2003				
Variable	*n*	Mean (SD)	*n*	Mean (SD)	*n*	Mean (SD)	Changes per 5 years‡	95% CI	*P*-value
Overall†	21 133	12.9 (1.3)	16558	12.9 (1.3)	15925	12.8 (1.2)	−0.08	−0.09, −0.07	<0.01
Demographic subgroup									
Age (years)†									
20–29	559	13.1 (1.1)	1743	13.0 (1.1)	1322	12.9 (1.1)	−0.12	−0.16, −0.07	<0.01
30–39	4189	12.9 (1.2)	3025	12.8 (1.3)	2283	12.7 (1.2)	−0.09	−0.12, −0.06	<0.01
40–49	5100	12.8 (1.5)	3863	12.6 (1.5)	2600	12.4 (1.5)	−0.18	−0.21, −0.15	<0.01
50–59	4653	13.1 (1.2)	3948	13.2 (1.1)	3395	13.0 (1.1)	−0.08	−0.11, −0.06	<0.01
60–69	3905	13.1 (1.1)	2233	13.1 (1.0)	3327	13.0 (1.0)	−0.04	−0.06, −0.01	<0.01
70+	2727	12.7 (1.3)	1746	12.6 (1.2)	2998	12.6 (1.2)	−0.05	−0.08, −0.02	<0.01
Residential areas									
20–49 years†									
Metropolitan	1748	12.9 (1.3)	1455	12.8 (1.3)	991	12.7 (1.2)	−0.12	−0.17, −0.07	<0.01
Cities	5561	12.8 (1.3)	4873	12.8 (1.4)	3394	12.6 (1.3)	−0.14	−0.16, −0.11	<0.01
Towns	2539	12.8 (1.4)	2303	12.8 (1.4)	1820	12.6 (1.4)	−0.12	−0.16, −0.08	<0.01
50–69 years†									
Metropolitan	1475	13.2 (1.1)	1010	13.1 (1.1)	1012	13.0 (1.0)	−0.07	−0.11, −0.03	<0.01
Cities	4501	13.1 (1.1)	3480	13.2 (1.1)	3724	13.1 (1.1)	−0.07	−0.09, −0.04	<0.01
Towns	2582	13.1 (1.1)	1691	13.1 (1.1)	1986	13.1 (1.1)	−0.05	−0.08, −0.02	<0.01
70 years†									
Metropolitan	396	12.7 (1.3)	229	12.6 (1.1)	390	12.6 (1.1)	−0.06	−0.13, 0.02	0.14
Cities	1395	12.7 (1.3)	867	12.6 (1.2)	1465	12.6 (1.2)	−0.06	−0.10, −0.02	0.01
Towns	936	12.6 (1.3)	650	12.6 (1.2)	1143	12.6 (1.2)	−0.03	−0.08, 0.02	0.21

SD – standard deviation; CI – confidence interval; metropolitan – 12 major cities and 23 Tokyo metropolitan wards with a population more than 1 000 000 people; cities – all cities with a population less than 1 000 000 people; towns – all small towns and villages.
Values are shown by means and SD.
†Adjusted for age as a continuous variable.
‡Calculated by general linear model using the raw data from 15 points of observation. Data are expressed as mean haemoglobin changes in value (95% CI).

Table 2 Trends in the prevalence of anaemia in women aged 20 years and over, according to age and residential areas: 1989–2003

	Prevalence (%)			Changes per 5 years‡			Hosmer–Lemeshow's goodness-of-fit§			
Variable	1989–1993	1994–1998	1999–2003	OR	95% CI	P for trend	df	χ^2	P-value	R^2¶
Overall†	16.5	17.6	18.6	1.08	1.05, 1.11	<0.01	8	68.6	<0.01	<0.01
Demographic subgroups										
Age (years)†										
20–29	13.4	12.8	15.4	1.12	0.98, 1.27	NS	8	7.7	0.47	0.01
30–39	16.8	18.9	20.6	1.14	1.08, 1.21	<0.01	8	4.2	0.83	<0.01
40–49	20.2	24.5	26.9	1.20	1.14, 1.27	<0.01	8	26.1	<0.01	<0.01
50–59	10.9	10.6	11.7	1.06	0.99, 1.13	NS	8	31.6	<0.01	<0.01
60–69	12.5	13.2	12.2	1.00	0.94, 1.07	NS	8	6.8	0.56	<0.01
70+	25.3	26.2	26.0	1.03	0.97, 1.09	NS	8	11.6	0.17	<0.01
Residential areas										
20–49 years†										
Metropolitan	16.8*	19.4	19.1*	1.12	1.02, 1.23	0.02	8	7.5	0.48	0.01
Cities	18.2	20.1	22.6	1.18	1.12, 1.24	<0.01	8	15.3	0.05	0.01
Towns	19.9	20.8	22.9	1.15	1.07, 1.23	<0.01	8	15.7	0.05	0.01
50–69 years†										
Metropolitan	10.6	11.4	10.8*	1.04	0.92, 1.17	NS	8	22.0	0.01	<0.01
Cities	11.6	11.0*	11.2**	0.99	0.93, 1.06	NS	8	66.8	<0.01	<0.01
Towns	12.1	12.9	14.0	1.10	1.01, 1.19	0.02	8	4.8	0.78	<0.01
70 years†										
Metropolitan	27.0	23.6	26.9	1.00	0.86, 1.16	NS	8	9.0	0.34	0.02
Cities	24.0	25.3	25.2	1.04	0.96, 1.13	NS	8	4.3	0.83	0.03
Towns	26.6	28.3	26.6	1.02	0.93, 1.12	NS	8	5.9	0.66	0.03

OR – odds ratio; CI – confidence intervals; NS – not significant; metropolitan – 12 major cities and 23 Tokyo metropolitan wards with a population more than 1 000 000 people; cities – all cities with a population less than 1 000 000 people; towns – all small towns and villages.
Values are shown in percentage (%).
† Adjusted for age as a continuous variable.
‡ Calculated by logistic models using the raw data from 15 points of observation. Data are expressed as ORs (95% CI). Significance level compared with small towns within the same age group in each time period: *$P<0.05$; **$P<0.01$.
§ The Hosmer–Lemeshow goodness-of-fit was used to assess goodness-of-fit for all models.
¶ The generalised coefficient of determination statictics, i.e. R^2, was used to describe the proportion of variability explained by the model.

models over 15 years. A higher prevalence of anaemia was observed in women aged 40–49 years and 70 years and older throughout all time periods, than in other age groups. Among six age groups, the highest OR for changes per 5 years was observed in women aged 40–49 years (OR 1.20, 95% CI 1.14, 1.27, $P<0.01$), followed by women aged 30–39 years (OR 1.14, 95% CI 1.08, 1.21, $P<0.01$). Changes in the prevalence of anaemia in other age groups were not statistically significant. In terms of residential areas, statistically significant changes in metropolitan areas and cities were observed only in women aged 20–49 years, and changes in towns were observed in women aged 20–49 years and 50–69 years. No statistically significant changes in all three areas were observed in women aged 70 years and older. In terms of residential differences on the prevalence of anaemia, the prevalence of anaemia in women aged 20–49 years living in metropolitan areas was statistically lower than in towns in 1989–1993 and 1999–2003. Statistically significant lower prevalence of anaemia was observed in women aged 50–69 years living in cities and cities and metropolitan areas than in towns in 1994–1998 and 1999–2003, respectively. No residential differences were observed in women aged 70 years and older throughout all three time periods. The Hosmer and Lemeshow goodness-of-fit tests indicated the models categorised by demographic subgroups fitted relatively well (P-values >0.03), except for some subgroups. The R^2 values for all models indicated that the explanatory variables in the models have little contribution.

Discussion

WHO proposes that the public health significance of anaemia be classified on the prevalence estimated from blood haemoglobin levels or haematocrit[10], with proposed levels of significance as follows: 'normal' (≤5%), 'mild' (5.0 to 19.9%), 'moderate' (20.0–39.9%), and 'severe' (≥40%). Our results clearly demonstrate a level of significance in Japanese women is either 'mild' or 'moderate', according to the WHO classification[10]. For the most recent time period (1999–2003), anaemia was particularly prominent in women aged 40–49 years (26.9%), in women aged 70 years and older (26.0%) and in women aged 30–39 years (20.6%). A lower prevalence of anaemia was found among women aged 50–59 years and 60–69 years, but the level remained high enough to warrant attention. Most importantly, the prevalence has been increasing.

In this study, we also observed higher prevalence of anaemia in towns, compared to metropolitan and cities, in all three periods, except for elderly women aged 70 years and older. Back in the 1960s and until the 1980s, anaemia was the major public health problem among Japanese women, especially among those in villages. Several factors were considered as possible reasons for higher prevalence of anaemia in villages compared to cities or towns. For example, undernutrition, higher number of pregnancies, overworking and parasite infections were discussed as possible risk factors[20]. Today, however, there is not much difference in nutrition and health environments between cities and villages due to the nationwide economic growth. Overnutrition, represented by increased prevalence of obesity, is now greater in towns than in metropolitan areas[21]. Further studies are needed to examine why the prevalence of anaemia remains high in towns as we observed in the present study, and whether other developed and Asian countries have similar situations to ours.

There are many causes of anaemia in a population. However, in terms of public health, iron deficiency is the most important cause of nutritional anaemia worldwide. Low iron intake may be a significant cause in Japanese women, especially in young women. The Estimated Average Requirement (EAR) for iron is 9.0 mg for menstruating adult women and 5.5 mg for non-menstruating adult women[22]. The actual average intake (and its SD in mg) in women aged 20–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years and over 70 years, according to NHNS-J 2003, was 7.0 (2.9), 7.3 (6.0), 8.9 (20.1), 8.7 (3.6), 9.3 (3.9) and 8.1 (3.5), respectively[23]. These data show that the prevalence of low iron intake might be high in young Japanese women. Second, diseases related to increased iron losses, such as 'menorrhagia' or leiomyoma, may be common in Japanese women. A 4-year follow-up study of 95 061 25- to 44-year-old premenopausal women in the United States, estimated the incidence of uterine leiomyoma at 12.8 per 1000 woman-years[24]. Although estimates of the incidence among Japanese premenopausal women vary between studies, approximately 30% of all women of reproductive age are susceptible to uterine leiomyoma in Japan[25]. The aetiology of anaemia (e.g. insufficient dietary iron intakes, high blood iron loss) needs further evaluation with the use of other indicators of iron status.

A major strength of this study is that this is the first study identifying prevalence and risks of iron deficiency and iron deficiency anaemia in young Japanese women using a large nationwide sample. However, there are some limitations that need to be highlighted. First, data are not obtained using a simple random sample. Rather, a stratified cluster sampling design is used to select participants. The smallest random sampling unit is a district, not an individual, and the number of households and size of households differ from district to district. Sampling design is consistent each year so we assume that there is no sampling effect on the equality of subgroups in this study. However, the response rate for the NHNS-J has declined recently; therefore, the estimates may differ greatly when they are calculated with the correct weight than when they are calculated without being weighted at all. In this study, we used non-weighted data for all analyses. Further assessment is needed once sample weights and imputation for non-response are fully taken into account in the methodology of NHNS-J in future.

A definition of anaemia in this study is another consideration. We estimated anaemia with a single measure, which was haemoglobin concentration below the WHO-established cut-off level[10]. The haemoglobin level drops when anaemia is present; however, such a drop cannot be used to distinguish between nutritional anaemia (such as iron deficiency) and anaemia from other causes. Binkin and Yip[26] reported that using haemoglobin to screen for iron deficiency detected only 37% of iron-deficient women in the United States. In order to detect iron deficiency as a risk for nutritional anaemia, WHO/CDC experts recommend using haemoglobin and ferritin (and the transferrin receptor where infection is common)[10]. The NHNS-J started monitoring ferritin in 2004. Therefore, we will review the prevalence of, and secular trends in, iron deficiency in the population once we have an adequate sample size. Another limitation is that we do not know the probability of a woman being at risk of chronic disease or menstruating. Lastly, the Hosmer–Lemeshow goodness-of-fit tests did not fit well in all of the models we tested and the R^2 values indicated that the explanatory variables used in all models had little contribution. Therefore, future research should focus on studying additional constructs that might explain changes in prevalence of anaemia in the Japanese women. None the less, the results must be interpreted with caution and further research is needed; still, this study provides baseline data for future public policy making and nutrition monitoring for high-risk subgroups (e.g. middle-aged women, women residing in towns).

In summary, this is the first study reporting long-term trends of anaemia in adult Japanese women, using data sets collected nationwide. Although some considerations are needed in interpretation of the findings, the study indicated that middle-aged women, especially those aged 40–49 years, are at a higher risk for developing anaemia. Data also indicated that there may be additional risks for women living in towns. Comprehensive efforts to reduce risks of anaemia are needed, and nutrition monitoring systems useful to collect the nationally representative samples also need to be developed.

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報　告　書

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資 料 集

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