Table 4 Multiple logistic regression analysis for fatty liver in the longitudinal study

	Age-adjusted OR	95% CI	Multivariate OR*	95% CI
Men				
Non-drinkers	1.00	References	1.00	References
Occasional drinkers	0.97	0.78–1.19	0.95	0.77–1.17
Daily moderate drinkers	0.73	0.59–0.90	0.72	0.58–0.89
Daily heavy drinkers	0.67	0.52–0.87	0.65	0.50–0.85
Women				
Non-drinkers	1.00	References	1.00	References
Occasional drinkers	0.83	0.65–1.05	0.81	0.63–1.04
Daily moderate drinkers	0.67	0.42–1.07	0.71	0.44–1.16
Daily heavy drinkers	0.08	0.29–2.26	0.74	0.25–2.17

* Adjusted by age, BMI, and smoking status

Discussion

The present study demonstrated that alcohol drinking may not be a major risk factor for fatty liver as assessed by ultrasonography in Japanese undergoing a health checkup. Thus, the prevalence of fatty liver in both sexes was significantly lower in daily drinkers than in non-drinkers. Occasional, daily moderate, and daily heavy drinking in men and occasional and daily moderate drinking in women fully adjusted for other factors were inversely associated with fatty liver in the cross-sectional study. Daily moderate and heavy drinking exerted protective effects against the development of fatty liver in men in the longitudinal study.

The low to moderate amounts of alcohol found to reduce type 2 diabetes, metabolic syndrome, and cardiovascular diseases have ranged widely [14–23]. However, low to moderate amounts of alcohol were usually defined as less than 30 g alcohol/day [34, 35, 38]. Further, the risk for cardiovascular diseases is lower when alcohol consumption is low to moderate, and the risk is higher when alcohol consumption is high, resulting in a dose-response curve that is J- or U-shaped [38]. It was also demonstrated that the threshold for non-cirrhotic and cirrhotic liver damage was reported to be less than 30 g alcohol/day, and risk increased with increasing daily intake [35, 39]. We estimated that alcohol consumption of daily heavy drinkers ranged from 46 g alcohol/day to 69 g or more than 69 g alcohol/day in the present study. We also demonstrated that even daily heavy drinking was inversely associated with fatty liver and that exclusion of daily heavy drinkers did not essentially alter the trend in both cross-sectional and longitudinal studies. However, we do not encourage heavy alcohol drinking since we focused the effect on fatty liver, but not on liver injury, and more than 30 g alcohol/day has been reported to be injurious to the liver [35, 39].

Ethanol is known to impair fat oxidation and stimulate lipogenesis in the liver [2, 3]. Although there is conflicting evidence, alcohol intake is reported to be associated with fatty liver in apparently healthy adult men in Spain, with alcohol abuse and obesity being equally strong risk factors for fatty liver in the Guangzhou area of China [12, 13]. Alcohol drinking was found to be a weaker risk factor for fatty liver than obesity in another study [25].

Although our results appear paradoxical on the surface, we speculate that the discrepancy may be related to the different proportion of heavy alcohol drinkers. Our results are in line with other reports that low alcohol drinking did not increase the risk for fatty liver in health checkup participants in Japan and that low to moderate alcohol drinking reduced liver steatosis and non-alcoholic steatohepatitis found in the severely obese in the USA [26, 27]. Further, it was recently demonstrated that modest wine consumption was associated with a reduced prevalence of non-alcoholic fatty liver disease [28].

Adding FBG or elevated blood pressure and hypertension did not alter the ORs in both cross-sectional and longitudinal studies, suggesting that the relationship between alcohol drinking and fatty liver was not confounded by these factors and the effect of alcohol drinking on fatty liver may be independent of improved glucose metabolism and endothelial function. The mechanism by which low to moderate alcohol drinking reduces type 2 diabetes, cardiac ischemic diseases, and the metabolic syndrome may be, in part, related to increased insulin sensitivity [20–23]. Insulin resistance causes accumulation of fat in the hepatocytes through lipolysis and hyperinsulinemia [4, 40]. Although we did not measure insulin sensitivity in the present study, we speculate that this may be increased in our population by alcohol drinking, thereby attenuating fatty liver.

A major limitation of the present study was the cross-sectional and retrospective longitudinal design. The subjects were limited to the Japanese participants undergoing a health checkup. Although it would have been preferable to follow up all participants in 2000 to investigate the risk factor for fatty liver in 2005 in a cohort manner, only 42.5% of the participants in 2000 received the medical checkup in 2005. In addition, alcohol consumption was self-reported, and the drinkers were roughly divided into four groups according to the frequency of drinking for logistic regression analyses, which may result in inaccuracies. Finally, although histological diagnosis is more accurate, we had to rely on ultrasonography for the purposes of the present study. Ultrasonography cannot distinguish steatosis and steatohepatitis, with the result that it may be unclear if the participants drinking alcohol have liver damage. However, it has been widely used to assess fatty liver since it is a non-invasive procedure with relatively high sensitivity and specificity for screening purposes [1, 12, 13, 25, 26, 36, 37]. The prevalence of fatty liver, 23.9% in men and 10.3% in women in the present study, is consistent with values in a previous Japanese report [41].

In conclusion, alcohol drinking may not be a major risk factor for fatty liver on ultrasonography in Japanese undergoing a health checkup. However, we should be prudent, and the available data do not yet provide a rationale for encouragement of alcohol consumption. Future cohort studies assessing the influence of differing amounts of alcohol are necessary to confirm whether alcohol drinking may indeed not be a risk for fatty liver.

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日本人の食事摂取基準(2010年版)の策定の概要

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日本人の食事摂取基準(2010年版)の策定の概要*

keywords：食事摂取基準、総論、活用

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昨年(2009年)、厚生労働省から「日本人の食事摂取基準(2010年版)」が発表された。2010年版は2005年版で示された考え方が踏襲されているが、数値の時代から理論・理屈の時代に、そして、活用は数値をあてはめる時代から考える時代に入ったという印象を強く受ける記述になっている。食事摂取基準の基本的な考え方はほとんどが「総論」で記述されている。「総論」の特徴をあげるとすれば、「活用の基礎理論」が盛り込まれたこと、活用目的が3種類に分けられて記述されたこと、そして、アセスメントの重要性が強調されたことであろう。これで現場が食事摂取基準をじゅうぶんに活用できるかといえば、そこまでは至っていない印象が強いが、それでも、栄養管理業務が医療業務のひとつであり、「科学」であるとすれば、食事摂取基準の理論、特に、総論の内容は栄養管理に携わる者が必ず理解していなければならないことは明らかである。

1. はじめに

昨年(2009年)、厚生労働省から「日本人の食事摂取基準(2010年版)」が発表された。これは厚生労働省のホームページ上に全文が掲載されていて、pdfファイルとしてダウンロードすることができるので、ぜひ、ご覧いただきたい(http://www.mhlw.go.jp/bunya/kenkou/sessyu-kijun.html)。「日本人の食事摂取基準(2010年版)」は全306ページから構成されている。これだけ大量の情報を正確に読み、理解し、活用するのは至難の業だと思われる。そこで、どこがエッセンスであり、どこに力を入れて読めば、正しく理解し、正しく活用できるかについて考えてみることにしたい。

なお、この文章は、「日本人の食事摂取基準(2010年版)」を読まずに済ませたい読者を対象とした、「日本人の食事摂取基準(2010年版)」の紹介文ではないため、あらかじめ注意をされたい。

2. 何よりも「総論」が大切

全体は「総論」と「各論」に分かれている。食事摂取基準の考え方の基本がすべて「総論」で説明されているので、どの栄養素(エネルギーも含む)に興味をもっているか、どの栄養素(エネルギーも含む)についての情報を必要としているかにかかわらず、総論はていねいに読む必要がある。つまり、読解の順序は、

「総論」→「各論の中で必要とする部分」

となるであろう。

「総論」は、「策定の基礎理論」と「活用の基礎理論」のふたつの部分に分かれている。注意すべきことは、両者とも、基礎的な理論が記述されたものであり、事例集でも指示書でもないことである。つまり、ここに書かれている基礎理論を理解し、それにしたがって、目の前の状況をよく観察し、しっかりと自分の頭を使って考えて食事摂取基準を活用することが求められている。この点でも、2010年版は2005年版の考え方を踏襲し、その考え方や活用方法

The outline of the Dietary Reference Intakes for Japanese (2010)

をさらに前進させたものと理解できる。ここで大切なことは、「策定の基礎理論」が正しく理解されなければ、「活用の基礎理論」は理解できないということである。したがって、食事摂取基準の使い方(活用)に関する情報を得たいと考える場合にも、「策定の基礎理論」の正しい理解が前提となる。

ところで、「日本人の食事摂取基準(2010年版)」の基本中の基本は、やはり、5種類(エネルギーを含めれば6種類)の指標の意味と目的を正しく理解することであろう。2005年版とほとんど変更はないが、栄養素については基本的な概念をまとめた表が添えられており、理解に役立つであろう(表)。ここでも、指標の名称の丸暗記ではなく、それぞれの指標がもつ意味を深く理解することの大切さが強調されている。

表　栄養素の指標の概念と特徴のまとめ　日本人の食事摂取基準(2010年版)から一部抜粋

目的	摂取不足による 健康障害からの回避	摂取過剰による 健康障害からの回避	生活習慣病の 一次予防
指標	推定平均必要量、 推奨量、目安量	耐容上限量	目標量
値の算定根拠となる 主な研究方法	実験研究、疫学研究 (介入研究を含む)	症例報告	疫学研究 (介入研究を含む)
健康障害が生じるまでの 典型的な摂取期間	数か月間	数か月間	数年～数十年間
通常の食品を摂取している 場合に注目している 健康障害が発生する可能性	ある	ほとんどない	ある
サプリメントなど、通常以外の食品を摂取している場合に注目している健康障害が発生する可能性	ある (サプリメントなど には特定の栄養素しか 含まれないため)	ある (厳しく注意が必要)	ある (サプリメントなど には特定の栄養素しか 含まれないため)
算定された値を 守るべき必要性	可能な限り考慮する(回避したい程度によって異なる)	必ず考慮する	関連するさまざまな 要因を検討して考慮する
算定された値を守った 場合に注目している 健康障害が生じる可能性	推奨量付近、目安量付近であれば、可能性は低い	上限量未満であれば、 可能性はほとんどないが、 完全には否定できない	ある(他の関連要因によっても生じるため)

つまり、食事摂取基準は数値の時代から、理論・理屈の時代に、そして、活用は、数値をあてはめる時代から考える時代に入ったと言ってよいであろう。

3.「活用の基礎理論」が示すもの

今回の食事摂取基準で初めて、「活用」を強く意識した記述がなされるようになった。栄養所要量と呼ばれていたころも含めて、食事摂取基準が本来、使うべきガイドラインであることを考えれば当たり前のことである。「活用の基礎理論」で特に強調されていることは次の4点であろう。

①対象者の明確化(疾患を有する者も含む)

狭義には「健康な個人、ならびに、健康な人を中心として構成されている集団」とあるが、「何らかの軽度な疾患(例えば、高血圧、脂質異常症、高血糖)を有していても自由な日常生活を営み、当該疾患に特有の食事指導、食事療法、食事制限が適用されたり、推奨されたりしていない者を含む」とされている。さらに、「特有の食事指導、食事療法、食事制限が適用されたり、推奨されたりする疾患を有する場合、または、ある疾患の予防を目的として特有の食事指導、食事療法、食事制限が適用されたり、推奨されたりする場合には、その疾患に関連する治療ガイドライン等の栄養管理指針を優先して用いるとともに、食事摂取基準を補助的な資料として参照することが勧められる」とある。このことは、疾患を有する者、すなわち、入院中の患者や、外来へ通院している患者に用いるガイドラインのひとつとして食事摂取基準を位置づけており、臨床栄養分野の栄養士、管理栄養士にとっても食事摂取基準が重要なガイドラインのひとつであることを示しているものと考えられる。

②活用目的の明確化

食事摂取基準を活用する主な目的として「食事改善」と「給食管理」の2つをあげ、さらに、前者を「対象者を個人として扱う場合」と「集団として扱う場合」に分けて、それぞれについての理論が説明されている。食事摂取基準を用いる者は、この中のどれを目的として用いるのかを明らかにしたうえで、その理論に基づいて用いることが勧められている。

③アセスメントの重要性

上記のどの目的に用いる場合においても、アセスメントの重要性が強調されている。

アセスメント→プランニング→実行→評価(アセスメント)→・・・

という無限ループで栄養管理などの業務を行っていくことが勧められている。

④食事アセスメント理論の重要性

食事アセスメント理論への正しい理解と、それに基づく

食事アセスメント結果の正しい解釈の重要性が強調されている。特に、食事アセスメントにおける測定誤差の存在とその程度について具体的な記述があり、食事アセスメントにおける測定誤差に関する知識と理解が食事摂取基準の正しい活用に重要な役割を果たすことが強調されている。

しかしながら、他の章に比べると、この章の参考文献はかなり少ない。これは、この章の信頼度が他の章に比べて低いのではないかということを示しており、食事摂取基準を使う側からすれば、不安材料である。そして、同時に、この分野の研究や調査が不足しており、それを推進しなければならないことを示していると理解できるだろう。

4. 演習問題

総論で述べられている「理論・理屈」が、食事摂取基準を正しく使う（活用する）上で大切であることを理解し、自分の食事摂取基準の理解度がどの程度であるかを確認していただくことを目的として、演習問題を作ってみた。自信のある人は、「日本人の食事摂取基準(2010年版)」を読まずに、自信があまりないか、いままでに食事摂取基準についてあまり学んだ経験がない人は「日本人の食事摂取基準(2010年版)」を一通りお読みいただいた後に、解答していただきたい。管理栄養士・栄養士の友人や同僚と意見交換をしたり、先輩や先生の意見を求めたりするのもよいかもしれない。

解答は、(ほぼ正しい)、(ほぼ誤り) のいずれかである。ヒントを参考にしていただくのもよいかもしれない。

Q1 推定エネルギー必要量を習慣的に摂取していればほぼ太りもやせもしないと考えてよい。

（ヒント）食事摂取基準の特徴のひとつである「確率的な考え方」を正しく理解しているかどうかを問う問題である。

Q2 通常の食品だけを用いている場合、たんぱく質の推奨量を超えた献立を作ることは「たんぱく質の食事摂取基準からみて」悪いことではない。

（ヒント）「推奨量」の定義を正しく理解できているかどうか、摂取量と摂取不足確率との関係を表す図を正しく理解できているかどうかを問う問題である。

Q3 55歳女性。骨折予防のためには、カルシウムは余裕をみて650mg/日くらいよりも850mg/日くらい食べるほうがよい。

（ヒント）これも、「推奨量」の定義を正しく理解できているかどうか、摂取量と摂取不足との関係を表す図を正しく理解できているかどうかを問う問題である。

Q4 ある日の給食の献立のビタミンAが耐容上限量を超えていた（注意：耐容上限量は2005年版における上限量と同じ意味である）が、この献立に問題はない。

（ヒント）食事摂取基準の特徴のひとつである「習慣」についての問題である。

Q5 サプリメントを使っていない人でも耐容上限量には気をつけるべきである。

（ヒント）サプリメントと耐容上限量の2つが、「摂取量」を通して正しく理解できているかどうかを問う問題である。

Q6 食事摂取基準は病気をもっている人は対象としていない。

（ヒント）食事摂取基準の対象者に関する基本的な問題である。

Q7 習慣的な摂取量が目安量を下回っていたら、不足していると考えられる。

（ヒント）目安量の定義を正しく理解できているかどうかを問う問題である。

Q8 一般的にいって、成人の推奨量と小児の推奨量はほぼ同じくらいの精度をもっている。

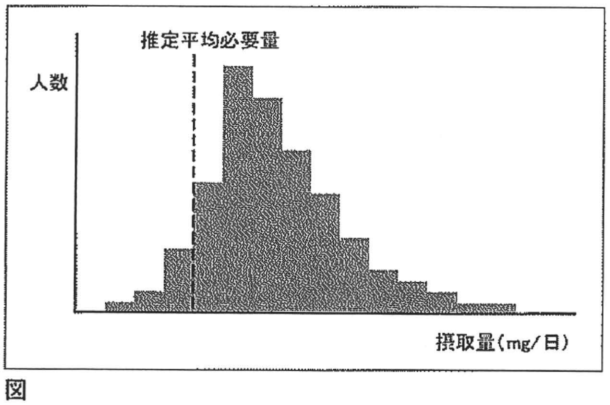
（ヒント）小児の食事摂取基準の数値がどのように算定されているかに関する知識を問う問題である。

Q9 推奨量と目標量はほぼ同じ期間の習慣的な摂取量を考えて算定されている。

（ヒント）「習慣的な摂取量」の「習慣的」が示す意味は指標によって異なることを正しく理解できているかどうかを問う問題である。

Q10 1日間の秤量食事記録法を用いて、ある集団のある栄養素の摂取量を調べた。摂取量の分布が図のようになった。真の不足者数はこの方法で得られる不足者数よりも多い。

（ヒント）食事調査における申告誤差に関する知識を実際に即して理解できているかどうかを問う問題である。



図

Q11 たんぱく質には耐容上限量が設定されていない。このことは、アミノ酸サプリメントの安全性を保証していると考えてよい。

（ヒント）「耐容上限量が設定されていない」ことが示す意味を正しく理解できるかどうかを問う問題。

Q12 ビタミンCの習慣的な摂取量が推定平均必要量付近であると、およそ50%の確率で、ビタミンC欠乏症である壊血病に罹ると考えられる。

（ヒント）どのような状態をもって「不足」とするかは栄養素によって異なる。ビタミンCが「不足」するのはどのような状態のときかについての知識を問う問題。

Q13 職場の給食施設では、食べに来ている人をひとりずつ調査できない場合が多い。このような給食施設では、性・年齢階級、身体活動レベルを考慮した給食献立の作成は無理である。

（ヒント）食事摂取基準では、対象者のアセスメントを行い、その結果に基づいて給食計画を立てることを勧めているが、「アセスメント」とは何かについてじゅうぶんに理解できているかどうかを問う問題。

5. 解答例

解答例を作ってみた。ただし、あくまでも著者の解釈であって、正解とは限らない。「日本人の食事摂取基準（2010年版）」をしっかりとお読みいただき、栄養士・管理栄養士の友人や同僚と意見交換をしたり、先輩や先生の意見を求めたりして、自分なりの解答を作っていただければと思う。

A1 たとえば、同じ性、年齢階級、身体活動レベルの人が100人いた場合、それぞれの人のエネルギー必要量は少しずつ異なる。その平均値がこの値だろうという推定値が推定エネルギー必要量です。それを個人に戻して考えると、その人の必要量を測定できない場合、推定値としてもっとも確からしい値が推定エネルギー必要量といえる。しかし、その人の本当の必要量はこの値とは異なるから、推定必要量を摂取すれば、体重は増えるか、または減るであって、体重が保たれるわけではない。どうなるかは食べてみないとわからない（食べてみればわかる）。

A2 推奨量程度のたんぱく質を摂取していれば、たんぱく質の不足はほぼだれにも起こらないと考えられる。それ以上を摂取しても、同じく、ほぼだれにも不足は起こらないと考えられる。したがって、不足を避けるという観点からは両者にそれほど大きなちがいはない。一方、通常の食品だけからたんぱく質を摂取している限り、過剰摂取による健康障害が起こるほど大量に摂取するとはほとんど考えられない。たんぱく質が多い食事は脂質も多く、また、価格も高くなりやすいといった問題が生じやすいかもしれないが、この問題では、「悪いことではない」と答えるのが正しいであろう。

A3 食事摂取基準では、カルシウムには推定平均必要量と推奨量が示されていて、この対象者における推奨量は650mg/日であり、この摂取量であれば、およそ97.5%の女性で不足していないことが示されている。850mg/日を摂取すれば不足による健康障害のリスクはさらに下がるが、新たにその恩恵を受ける人はわずかに2%程度で、残りの人には新たなメリットはない。これらのことから、「良いことはそれほどない」と考えるのが正しいであろう。

A4 ビタミンAは食品によってその含有量が大きく異なる代表的な栄養素である。献立によってはビタミンAが耐容上限量を上回ってしまうことがあるかもしれない。しかし、食事摂取基準は、習慣的な摂取量についての値であって、1食の中に含まれる栄養素量の過不足を判断するためのものではない。したがって、この献立には問題はないと考えられる。

A5 断言はできないかもしれないが、通常の食品だけを摂取している（サプリメントも強化食品を使っていない）人の場合、すべての栄養素について、習慣的な摂取量が耐容上限量を超えるような食べ方になる可能性は極めて低い。したがって、サプリメントを使っていない人の場合は、事実上、耐容上限量には気をつけなくてもよいと考えられる。

A6 有病者も食事摂取基準を用いる対象者に入る。ただし、その病気のための特別の食事管理を必要とする場合は、その食事管理が食事摂取基準よりも優先される。しかし、病気をもっていても、その病気に特別の食事管理が求められていない栄養素については、食事摂取基準に従うことになり、また、特別の食事管理を必要とはしない病気の場合には、健康な人と同じように食事摂取基準を用いるのが正しいであろう。

A7 目安量は、不足が観察されない集団におけるその栄養素の摂取量の中央値として与えられる。不足している人がいない集団であるから、中央値ではなくて最低値を選んでもよいはずであるが、他の集団の中に、必要量がもっと多い人がいるかもしれない。その人に対しても不足しないであろう数値として中央値が用いられる（中央値がこの目的にもっとも適した指標というわけではないが、他に適切な指標が存在しないという理由によるのであろう）。これは、その栄養素を摂取量が目安量を下回っていても「不足していない」可能性がかなりあることを示している。つまり、目安量よりも摂取量が少なくても「不足している」という判断はできない。逆に、目安量よりも摂取量が多い場合は、「不足している可能性はほとんどない」といえる。

A8 食事摂取基準で参考になる研究のほとんどは成人を対象に行われる。特に、推定平均必要量を決めるための出納実験を小児で行うのは研究倫理上、困難である。そのため、成人で実験を行って値を定め、次に、身体の大きさのちがいや成長による付加的な必要量などを考慮して、小児の数値を推定する。したがって、小児の数値は成人の数値に比べて信頼度は総じて低いと考えるべきであろう。

A9 出納実験を行って必要量を測定した場合、はじめに推定平均必要量を求め、その次に、実験で観察された必要量の個人差（必要量の分布幅）を用いて推奨量を求める。さらに、必要量の個人差の分布幅を正確に測定できた栄養素はそれほど多くなく、多くの栄養素群でひとつの値を暫定的に用いているのが実情である。したがって、推定平均必要量のほうが推奨量よりも信頼度の高い数値であろうと考えられる。

A10 食事記録法をはじめ、ほとんどの食事調査法で過小申告が認められる。次に、1日間の摂取量の分布は習慣的な摂取量の分布よりも広くなる。したがって、この2つの問題を考慮すると、真の習慣的な摂取量の分布は、この図よりも全体として右にずれ、かつ、幅が狭いものと推定される。このことから、真の不足者数は、この図から推定される不足者数よりも少ないものと予想される。

A11 「耐容上限量が設定されていない」のは、過剰摂取による明確な健康障害の報告が文献上、見いだされなかったことを示すだけであり、無限に摂取しても安全である（健康障害は生じない）ことを示すものではない。したがって、アミノ酸サプリメントの安全性を保証しているわけではない。

A12 ビタミンCの推定平均必要量は、その血漿濃度で決められている。しかし、壊血病ではなく、心臓血管系の疾病予防効果ならびに有効な抗酸化作用が期待できる濃度が用いられている。この濃度は壊血病を予防する濃度よりも高いから、推定平均必要量付近を摂取していても壊血病が50％の確率で発症するわけではない。

A13 職場の給食施設利用者の性・年齢の分布や、利用者がどの食事を選択し、摂取しているかを知るのは困難な場合が多い。しかし、その職場の職員構成(性・年齢の分布)に関する情報はほとんどの職場で存在するであろう。また、職員の職務内容から身体活動レベルの分布を推定することも、限界はあるが、不可能ではない。したがって、あくまでも限定付きではあるが、これらの情報(これもアセスメントのひとつである)を給食献立の作成に活用することが考えられる。

6. おわりに

「日本人の食事摂取基準(2010年版)」は2005年版と比べて、それほど大きく変わってはいない。むしろ、2005年版で示された考え方を踏襲し、さらに、それを推し進めたものと理解できる。そして、2005年版では、じゅうぶんに踏み込めていなかった点や、あいまいであった記述に対して、少しではあるにせよ、ていねいかつ明確な説明が試みられている。この点に注意して、読んでいただければ、2010年版の真価を理解していただけることと思う。

繰り返しになるが、食事摂取基準の考え方と、活用時に注意すべき事柄の多くは、「総論」で説明されている。総論をていねいに読み、そこに書かれていることを完全に理解すること、それが食事摂取基準を正しく理解し、正しく活用するための唯一、最良、最短の方法であることをご理解いただきたい。

推薦図書

食事摂取基準の基本的な考え方や活用について理解するためには、『佐々木敏. 食事摂取基準入門--そのこころを読む--. 同文書院, 2010』を、食事摂取基準の理論的基礎概念であるEBNや確率論など、疫学に関連する部分の知識を得るためには、『佐々木敏. わかりやすいEBNと栄養疫学. 同文書院, 2005』を読まれることをお勧めする。日本人の食事摂取基準(2010年版)はこれらに書かれている基本事項を理解しているものとして書かれている点に注意が必要であろう。

ELSEVIER

Nutrition 26 (2010) 508–514

NUTRITION

www.nutritionjrnl.com

Applied nutritional investigation

Neighborhood socioeconomic status in relation to dietary intake and insulin resistance syndrome in female Japanese dietetic students

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Manuscript received May 25, 2009; accepted August 17, 2009.

Abstract

Objective: An increasing number of studies in Western countries have shown that living in a socioeconomically disadvantaged neighborhood is associated with unfavorable dietary intake patterns and health status. However, information on such neighborhood socioeconomic differences in diet and health among different cultural settings, including Japan, is limited. This cross-sectional study examined the association of neighborhood socioeconomic status (SES) with dietary intake and a summary score of the insulin resistance syndrome (IRS) in a group of young Japanese women.
Methods: Subjects were 1081 female Japanese dietetic students aged 18 to 22 y residing in 295 municipalities in Japan. Neighborhood SES index was defined by seven municipal-level variables, namely unemployment, household overcrowding, poverty, education, income, home ownership, and vulnerable group, with an increasing index signifying increasing neighborhood socioeconomic disadvantage. Dietary intake was estimated using a validated, comprehensive self-administered diet-history questionnaire. Measurements of body mass index, systolic blood pressure, fasting high-density lipoprotein cholesterol, triacylglycerol, glucose, and insulin were combined into an IRS score, with an increasing score signifying increasing levels of components of the IRS.
Results: Neighborhood SES index was not associated with most of the dietary variables, body mass index, high-density lipoprotein cholesterol, triacylglycerol, or glucose. However, neighborhood SES index was significantly positively associated with systolic blood pressure, insulin, and IRS score, after adjustment for potential confounding or mediating factors, including household SES, dietary, and lifestyle factors.
Conclusion: Neighborhood socioeconomic disadvantage was associated with unfavorable profiles of the IRS score, but not dietary intake, in a group of young Japanese women.

Keywords: Neighborhood socioeconomic status; Diet; Insulin resistance syndrome; Young women; Japan; Epidemiology

Introduction

Because living conditions are shaped by characteristics of the residential environment, neighborhood characteristics may have some impact on lifestyle factors and, hence, on health status, beyond any effect of the characteristics of the individual. In fact, an increasing number of studies conducted in Western countries have shown that living in a socioeconomically disadvantaged neighborhood is associated with unfavorable dietary intake patterns [1–4] and an unfavorable profile of the insulin resistance syndrome (IRS) [5–11].

However, information on the relation of neighborhood socioeconomic status (SES) with diet and health in other countries is sparse, including Japan. Given the unclear or even inverse association between individual SES and health outcomes observed in the Japanese [12–14] vis-à-vis the

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0899-9007/10/$ – see front matter
doi:10.1016/j.nut.2009.08.025

consistent positive associations of individual and neighborhood SES with diet and health in Western populations [1–11,15–17], the association of neighborhood SES with dietary intake and health outcomes may differ between Western countries and Japan. In a study of young Japanese women, for example, neighborhood SES was not materially associated with dietary intake, but increasing neighborhood socioeconomic disadvantage was associated with increasing body mass index (BMI) [18].

In the present study, we examined the association of a neighborhood SES index, recently formulated for Japanese conditions [19], with selected dietary variables, as assessed using a previously validated, comprehensive self-administered diet-history questionnaire (DHQ) [20–23], and a summary score of the IRS, developed by Diez Roux et al. [5], in a group of young Japanese women. We hypothesized that neighborhood socioeconomic disadvantage is associated with unfavorable profiles of the IRS score, but not dietary intake.

Materials and methods

Study sample

This observational cross-sectional study was conducted from February to March 2006 and from January to March 2007 in female Japanese dietetic students from 15 institutions in Japan ($n = 1176$). A detailed description of the study design and survey procedure has been published elsewhere [24,25]. Written informed consent was obtained from each participant and from a parent for participants younger than 20 y. The study protocol was approved by the ethics committee of the National Institute of Health and Nutrition, Japan.

In Japan, the 2372 municipalities consisted of 164 wards, 736 cities, 1178 towns, and 294 villages (as of October 1, 2005) [26]. We used municipalities as proxies for neighborhoods [18,27], which is in accordance with previous Western studies where some administrative divisions are used as proxies for neighborhoods [1–11]. Study participants were linked to their municipalities using their home addresses.

For analysis, we selected women aged 18 to 22 y ($n = 1154$). We then excluded women with previously diagnosed diabetes, hypertension, or cardiovascular disease ($n = 1$) and those with missing information on the variables used ($n = 72$). The final analysis sample consisted of 1081 women who resided in 295 municipalities in Japan.

Neighborhood SES index

We constructed a neighborhood SES index at the municipality level [18,27] using seven variables determined by a factor analysis [19]. These variables were unemployment (percentage of unemployed persons ≥15 y old), household overcrowding (average floor space per residential dwelling), poverty (number of households receiving public assistance per 1000 households), education (percentage of persons 20–64 y old who had completed college or university), income (total taxable income divided by total population), home ownership (percentage of owned houses to total residential households), and vulnerable groups (percentage of households of single persons ≥65 y old to total households) [19]. Data were derived from the 2005 census [26] and other governmental surveys [26,28,29]. These seven variables were combined into a neighborhood summary score (i.e., neighborhood SES index) constructed by summing Z-scores for each of the seven variables (for unemployment, poverty, income, and vulnerable groups, data were log-transformed before calculating Z-scores; Z-scores for household overcrowding, education, income, and home ownership were multiplied by -1 before summing), with a higher neighborhood SES index signifying increasing neighborhood socioeconomic disadvantage [19]. A detailed description of the neighborhood SES index has been published elsewhere [18].

Dietary intake

Dietary habits during the preceding month were assessed using a comprehensive self-administered DHQ. Details of the DHQ's structure, calculation of dietary intake, and validity for commonly studied nutritional factors have been published elsewhere [20–25]. Briefly, the DHQ is a structured 16-page questionnaire that asks about the consumption frequency and portion size of selected foods commonly consumed in Japan and the general dietary behavior and usual cooking methods [20]. Estimates of daily intake for foods (150 items in total), energy, and selected nutrients were calculated using an ad hoc computer algorithm for the DHQ [20,23] based on the *Standard Tables of Food Composition in Japan* [30]. Dietary variables examined in this study were dietary energy density [24] and potential renal acid load [25], variables significantly associated with several metabolic risk factors in the present population, and their main determinants (energy-providing nutrients, dietary fiber, minerals, and selected food groups). To minimize the influence of dietary misreporting, an ongoing controversy in studies that collect dietary information using self-report instruments [31], dietary variables were energy adjusted using the density method (except for energy density).

IRS score

A summary score of IRS developed by Diez Roux et al. [5] was calculated based on measurements of BMI, systolic blood pressure, fasting high-density lipoprotein cholesterol, triacylglycerol, glucose, and insulin. Detailed descriptions of the measurement of each component have been published elsewhere [24,25]. These six variables were combined into a summary IRS score constructed by summing Z-scores for each of the six variables (for triacylglycerol and insulin, data were log-transformed before calculating Z-scores; Z-scores for high-density lipoprotein cholesterol were multiplied by -1 before summing), with an increasing score signifying increasing levels of components of the IRS. A detailed description of the IRS score has been provided by Diez Roux et al. [5].

Other variables

Based on the reported home address, each participant was grouped into one of six regions (Hokkaido and Tohoku; Kanto; Hokuriku and Tokai; Kinki; Chugoku and Shikoku; or Kyushu) and into one of three municipality levels (ward; city; or town and village). The participant was also grouped into one of four institution types (4-y private, 2-y private, 4-y public, or 2-y public) based on the institution she attended and into one of three living statuses (living with family, living alone, or living with others), as self-reported in a lifestyle questionnaire.

Table 1
Dietary, metabolic, and lifestyle characteristics of 1081 Japanese women aged 18 to 22 y*

Variable	
Food intake (g/1000 kcal)	
Cereals and potatoes	241.3 (237.9–244.7)
Confectioneries and sugars	40.2 (39.1–41.3)
Fats and oils	11.8 (11.4–12.1)
Fruits and vegetables	179.5 (173.9–185.1)
Fish, meat, and eggs	81.7 (80.1–83.3)
Dairy products	91.0 (86.7–95.3)
Nutrient intake	
Protein (percent energy)	13.5 (13.4–13.6)
Fat (percent energy)	29.2 (28.9–29.5)
Carbohydrate (percent energy)	55.7 (55.4–56.1)
Dietary fiber (g/1000 kcal)	6.9 (6.7–7.0)
Phosphorus (mg/1000 kcal)	517 (511–522)
Potassium (mg/1000 kcal)	1111 (1096–1127)
Calcium (mg/1000 kcal)	283 (277–289)
Magnesium (mg/1000 kcal)	121 (119–123)
Dietary energy density (kcal/g)	1.41 (1.40–1.43)
Potential renal acid load (mEq/1000 kcal; measurement of diet-induced acid–base load)	5.90 (5.66–6.16)
Body mass index (kg/m^2)	21.4 (21.2–21.5)
Systolic blood pressure (mmHg)	106.3 (105.6–106.9)
High-density lipoprotein cholesterol (mg/dL)	70.8 (70.0–71.5)
Triacylglycerol (mg/dL)†	56.2 (54.8–57.5)
Glucose (mg/dL)	84.0 (83.7–84.4)
Insulin (ng/mL)†	7.4 (7.2–7.7)
Current smokers	2.3
Current alcohol drinkers	41.9
Physical activity (total metabolic equivalent-hours/d)	33.9 (33.8–34.0)

* Values are means (95% confidence intervals) or percentages of participants.
† Calculated using back-transformation of natural-log transformed values.

Current smoking (yes or no) and current alcohol drinking (yes or no) were self-reported in the lifestyle questionnaire and DHQ, respectively. Physical activity was computed as the average metabolic equivalent-hours score per day on the basis of the frequency and duration of five activities (sleeping, high- and moderate-intensity activities, walking, and sedentary activities) over the preceding month, as reported in the lifestyle questionnaire [24].

Statistical analysis

All statistical analyses were performed using SAS 9.1 (2003, SAS Institute Inc, Cary, NC, USA). Using the PROC GLM procedure, linear regression models were constructed to examine the association of neighborhood SES index with dietary variables and the summary IRS score and its components. For analyses, participants were categorized into quartiles according to neighborhood SES index. Multivariate-adjusted mean values (with 95% confidence intervals) of dietary variables and the summary IRS score and its components were calculated by quartile of neighborhood SES index. Potential confounding or mediating factors included in the multivariate models were survey year [24,25,27], household SES variables, i.e., institution type [18,27,32] and living status [18,27,33], and non-dietary lifestyle factors, i.e., current smoking status, current alcohol drinking status, and physical activity [18]. In the analysis of the summary IRS score and its components, dietary factors, i.e., dietary energy density [24] and potential renal acid load [25], were also included. In addition, geographical variables, i.e., region [18,27] and municipality level [18,27], were included, considering regional or urban–rural differences in neighborhood SES in Japan [19,34,35], although this may be an over-adjustment. We tested for linear trends with increasing levels of neighborhood SES index by assigning each participant the median value for the category and modeling this value as a continuous variable. All reported P values are two-tailed, and $P < 0.05$ was considered statistically significant. Because the great majority of municipalities had only a few study participants (median 1, interquartile range 1–3), no special methods were needed to account for within-neighborhood correlations in outcomes [4,5,18,27].

Results

Dietary, metabolic, and lifestyle characteristics are listed in Table 1. Mean dietary intakes of macronutrients were 13.5% of energy for protein, 29.2% of energy for fat, and 55.7% of energy for carbohydrate. Mean BMI was 21.4 kg/m^2. Geographic, household SES, and lifestyle characteristics according to quartile of neighborhood SES index are listed in Table 2. Neighborhood SES index was associated with region, municipality level, and institution type. The higher quartiles of neighborhood SES index (increasing neighborhood socioeconomic disadvantage) included more participants living in Hokkaido and Tohoku, Chugoku and Shikoku, and Kyushu and fewer participants living in Kanto, Hokuriku and Tokai, and Kinki; more participants living in wards and fewer living in towns and villages; and more participants attending 4-y private, 2-y private, and 4-y public institutions and fewer attending 2-y public institutions.

Dietary characteristics according to quartile of neighborhood SES index are presented in Table 3. Neighborhood SES index was not associated with any dietary variables examined after adjustment for possible confounding or mediating factors including household SES and non-dietary lifestyle variables, with the exception of a positive association with cereals and potatoes and a negative association with dairy products, phosphorus, potassium, calcium, and magnesium. Further adjustment for geographic variables did not change the results materially, with the exception of the loss of the above-mentioned associations (data not shown).

Components of IRS and summary IRS score according to quartile of neighborhood SES index are presented in Table 4. Neighborhood SES index was not associated with BMI, high-density lipoprotein cholesterol, triacylglycerol, or glucose. Conversely, higher neighborhood SES index (increasing neighborhood socioeconomic disadvantage) was significantly associated with higher systolic blood pressure, insulin, and IRS score, after adjustment for potential confounding or mediating factors, including household SES, non-dietary lifestyle, and dietary factors. However, these associations disappeared after further adjustment for geographic variables (data not shown).

Table 2
Geographic, household socioeconomic status, and lifestyle characteristics of 1081 Japanese women aged 18 to 22 y according to quartile category of neighborhood socioeconomic status index*

Variable	Quartile 1 ($n = 263$)	Quartile 2 ($n = 277$)	Quartile 3 ($n = 262$)	Quartile 4 ($n = 279$)	P†
Neighborhood socioeconomic status index (median)	−3.19	−0.94	0.22	4.07	—
Survey year					0.61
2006	41.4	36.8	47.7	40.1	
2007	58.6	63.2	52.3	59.9	
Region					<0.0001
Hokkaido and Tohoku	0	0.7	0.4	9.0	
Kanto	71.9	66.8	58.8	23.7	
Hokuriku and Tokai	8.8	22.7	19.5	2.5	
Kinki	16.0	7.2	1.5	15.8	
Chugoku and Shikoku	0.4	0.7	0	13.3	
Kyushu	3.0	1.8	19.9	35.8	
Municipality level					<0.0001
Ward	8.8	9.8	7.3	36.9	
City	78.3	89.2	86.6	59.9	
Town and village	12.9	1.1	6.1	3.2	
Institution type					<0.0001
4-y private	70.0	59.9	75.6	73.5	
2-y private	2.7	1.1	16.0	2.5	
4-y public	17.9	7.6	6.9	21.5	
2-y public	9.5	31.4	1.5	2.5	
Living status					0.06
Living with family	67.7	65.3	35.9	68.5	
Living alone	29.3	29.6	60.7	26.5	
Living with others	3.0	5.1	3.4	5.0	
Current smokers	2.3	1.4	3.1	2.5	0.57
Current alcohol drinkers	37.6	46.9	33.2	49.1	0.12
Physical activity (total metabolic equivalent-hours/d)	33.7 (33.4–34.1)	34.0 (33.7–34.3)	33.7 (33.4–34.1)	34.1 (33.7–34.6)	0.21

* Values are percentages of participants or means (95% confidence intervals) unless otherwise indicated.
† For categorical variables, a Mantel-Haenszel chi-square test was used; for continuous variables, a linear trend test was used, with the median value in each quintile category as a continuous variable in linear regression.

Discussion

As hypothesized, we found in this cross-sectional study of a group of young Japanese women that neighborhood SES was not materially associated with dietary intake, but increasing neighborhood socioeconomic disadvantage was associated with unfavorable profiles of the IRS score. To our knowledge, this is the first study to investigate the association of neighborhood SES with dietary intake and the IRS score in a Japanese population.

Inconsistent with several Western studies [1–4], but consistent with a previous Japanese study [18], we saw no material association between neighborhood SES and dietary variables. The reason for the present finding is unknown. Considering that Japan has long been shown to have lower inequality in individual SES than other developed countries [36], inequalities in neighborhood SES in Japan may be too low to have a measurable influence on dietary habits. Alternatively, the homogenous characteristics of participants in terms of individual SES (i.e., Japanese female dietetic students aged 18–22 y) may have hampered the identification of any meaningful association between neighborhood SES and dietary intake.

Consistent with previous Western studies [5–11], however, we did identify an association between neighborhood socioeconomic disadvantage and an adverse IRS score profile. There are several proximate mechanisms through which neighborhood characteristics could be hypothesized to influence the development of components of IRS [5]. Neighborhood SES may be related to components of IRS by an influence on behaviors linked to diet and physical activity, both of which may be related to insulin resistance [5,10,37]. This is unlikely in the present study, however, because the association between neighborhood SES and the IRS score remained after adjustment for physical activity and dietary factors.

Neighborhood SES may also be related to components of IRS through chronic stress, on the basis that, although sources of chronic stress (such as noise, violence, poverty, vigilance, threat, and alarm) are likely to vary across neighborhoods, chronic stress may be related to the development of components of IRS through endocrine pathways involving the hypothalamo–pituitary–adrenal axis or activation of the sympathetic nervous system [5,9,10,38,39]. Our results are consistent with this environmental stress theory for the role of the social environment in components of IRS, although

Table 3
Dietary characteristics of 1081 Japanese women aged 18 to 22 y according to quartile category of neighborhood socioeconomic status index*

Variable	Quartile 1 ($n = 263$)	Quartile 2 ($n = 277$)	Quartile 3 ($n = 262$)	Quartile 4 ($n = 279$)	$P^†$
Food intake (g/1000 kcal)					
Cereals and potatoes	236.9 (230.1–243.8)	236.5 (229.5–243.5)	244.7 (237.2–252.2)	247.0 (240.2–253.8)	0.02
Confectioneries and sugars	40.6 (38.4–42.7)	41.0 (38.8–43.3)	39.9 (37.5–42.3)	39.3 (37.2–41.5)	0.33
Fats and oils	11.8 (11.1–12.4)	11.9 (11.3–12.6)	11.3 (10.6–12.0)	12.0 (11.3–12.6)	0.69
Fruits and vegetables	180.5 (169.2–191.7)	190.0 (178.4–201.6)	172.2 (159.8–184.5)	175.1 (164–186.3)	0.31
Fish, meat, and eggs	83.2 (80.1–86.3)	82.7 (79.5–85.9)	76.2 (72.8–79.6)	84.3 (81.3–87.4)	0.63
Dairy products	94.3 (85.6–103.0)	91.6 (82.6–100.5)	102.4 (92.8–111.9)	76.5 (67.9–85.1)	0.003
Nutrient intake					
Protein (percent energy)	13.6 (13.4–13.8)	13.6 (13.4–13.8)	13.4 (13.1–13.6)	13.4 (13.2–13.6)	0.15
Fat (percent energy)	29.4 (28.8–30.0)	29.5 (28.8–30.1)	28.7 (28.0–29.4)	29.1 (28.5–29.7)	0.34
Carbohydrate (percent energy)	55.5 (54.8–56.2)	55.4 (54.6–56.1)	56.3 (55.5–57.1)	55.8 (55.0–56.5)	0.55
Dietary fiber (g/1000 kcal)	6.9 (6.6–7.1)	7.0 (6.8–7.3)	6.9 (6.6–7.2)	6.6 (6.4–6.9)	0.09
Phosphorus (mg/1000 kcal)	525 (514–536)	522 (511–534)	521 (508–533)	499 (488–510)	0.0005
Potassium (mg/1000 kcal)	1121 (1089–1152)	1131 (1099–1163)	1116 (1082–1150)	1079 (1048–1110)	0.03
Calcium (mg/1000 kcal)	290 (279–302)	287 (275–299)	296 (283–309)	261 (249–272)	0.0002
Magnesium (mg/1000 kcal)	122 (119–126)	122 (118–125)	123 (120–127)	117 (114–120)	0.02
Dietary energy density (kcal/g)	1.41 (1.38–1.44)	1.40 (1.37–1.42)	1.42 (1.39–1.45)	1.42 (1.40–1.45)	0.34
Potential renal acid load (mEq/1000 kcal; measurement of diet-induced acid–base load)	6.06 (5.55–6.57)	5.76 (5.24–6.29)	5.59 (5.03–6.15)	6.21 (5.71–6.72)	0.55

* Values are means (95% confidence intervals). Adjusted for survey year (2006 and 2007), institution type (4-y private, 2-y private, 4-y public, and 2-y public), living status (living with family, living alone, and living with others), current smoking (yes or no), current alcohol drinking (yes or no), and physical activity (total metabolic equivalents-hours/day, continuous). No significant association was observed after further adjustment for region (Hokkaido and Tohoku; Kanto; Hokuriku and Tokai; Kinki; Chugoku and Shikoku; and Kyushu) and municipality level (ward; city; and town and village).

† A linear trend test was used with the median value in each quintile category as a continuous variable in linear regression.

the association remains speculative because no variables associated with chronic stress were included in the present study.

In addition, the association between neighborhood SES and the IRS score may merely reflect geographic differences in the IRS score, because, although neighborhood SES was associated with region and municipality level, the association between neighborhood SES and IRS score disappeared after adjustment for these geographic variables. Alternatively, it is also possible that neighborhood SES contributes to regional and urban–rural differences in IRS score, and that geographic variables are a proxy for unmeasured neighborhood-level factors that covary with those we are investigating.

In this study, neighborhood SES index was not associated with BMI. However, we found in a recent report [18] studying a similar population that increasing neighborhood socioeconomic disadvantage was independently associated with increasing BMI. The reason for these apparently divergent results is unknown. Although the present study was conducted in students studying in a dietetic course for 1 to 4 y (and thus with more nutritional knowledge), the previous study [18] was conducted in freshmen students just entering a dietetic course (and thus with less nutritional knowledge), although, at least for intake of main food groups and macronutrients and BMI, mean values were similar between subjects in the present and previous [18] studies. Freshmen

Table 4
Components of insulin resistance syndrome and insulin resistance syndrome score of 1081 Japanese women aged 18 to 22 y according to quartile category of neighborhood socioeconomic status index*

Variable	Quartile 1 ($n = 263$)	Quartile 2 ($n = 277$)	Quartile 3 ($n = 262$)	Quartile 4 ($n = 279$)	$P^†$
Body mass index (kg/m^2)	21.0 (20.7–21.4)	21.3 (20.9–21.6)	21.7 (21.4–22.1)	21.4 (21.1–21.7)	0.11
Systolic blood pressure (mmHg)	105.2 (104.0–106.5)	105.2 (103.9–106.5)	106.0 (104.6–107.3)	108.5 (107.3–109.7)	<0.0001
High-density lipoprotein cholesterol (mg/dL)	71.0 (69.5–72.6)	71.6 (70.0–73.2)	70.3 (68.6–72.0)	70.1 (68.5–71.6)	0.28
Triacylglycerol (mg/dL)‡	54.4 (52.4–56.4)	54.9 (52.9–56.9)	59.6 (57.6–61.7)	56.0 (54.0–58.0)	0.36
Glucose (mg/dL)	84.2 (83.4–84.9)	84.0 (83.2–84.8)	83.9 (83.1–84.8)	84.0 (83.2–84.8)	0.80
Insulin (ng/mL)‡	7.1 (7.1–7.2)	7.4 (7.3–7.4)	7.3 (7.3–7.4)	7.9 (7.8–7.9)	0.03
Insulin resistance syndrome score	−0.11 (−0.23 to 0.01)	−0.08 (−0.20 to 0.04)	0.08 (−0.05 to 0.21)	0.11 (0.00 to 0.23)	0.004

* Values are means (95% confidence intervals). Adjusted for survey year (2006 and 2007), institution type (4-y private, 2-y private, 4-y public, and 2-y public), living status (living with family, living alone, and living with others), current smoking (yes or no), current alcohol drinking (yes or no), physical activity (total metabolic equivalents-hours/day, continuous), dietary energy density (kcal/g, continuous), and potential renal acid load (mEq/1000 kcal, continuous). No significant association was observed after further adjustment for region (Hokkaido and Tohoku; Kanto; Hokuriku and Tokai; Kinki; Chugoku and Shikoku; and Kyushu) and municipality level (ward; city; and town and village).

† A linear trend test was used with the median value in each quintile category as a continuous variable in linear regression.

‡ Calculated using back-transformation of natural-log transformed values.

students with less nutritional knowledge may have different results regarding the association of neighborhood SES with dietary intakes and health when compared with those observed in dietetic students with more nutritional knowledge.

Several limitations of the present study deserve mention. First, the participants were selected female dietetic students and may have healthier dietary habits and IRS profiles than the general population, although with regard to the intake of fat and carbohydrate, BMI, and systolic blood pressure at least, mean values in the present study were reasonably comparable to those of a representative sample of Japanese women aged 20 to 29 y (28.6% of energy, 56.2% of energy, 20.5 kg/m^2, and 106.9 mmHg, respectively; data not available for other variables) [40]. Thus, our results might not be extrapolated to the general Japanese population. Second, we relied on census-based measurements at the municipality level as proxies for neighborhoods, but these might not correspond to socially defined neighborhoods. In addition, municipality in Japan may be a somewhat large unit of neighborhoods, given that the median population of 295 municipalities was 121 779 (interquartile range 91 437–274 481). Our study is also limited by the use of the neighborhood SES score as an indirect proxy for the specific features of neighborhoods that may be more relevant [5]. Third, we used a self-administered semiquantitative dietary assessment questionnaire for dietary data collection. Although this questionnaire has been well validated [20–25], actual dietary habits were not observed, so the results should be interpreted cautiously. Fourth, we cannot rule out residual confounding. In particular, parents' SES variables were not available, although these may be at least partly reflected by household SES variables. Fifth, the cross-sectional nature of the study hampers the drawing of any conclusions on causal inferences between neighborhood SES and diet and the IRS.

Conclusion

Although no material association was seen between neighborhood SES and dietary intake, increasing neighborhood socioeconomic disadvantage was associated with unfavorable IRS score profiles in a group of young Japanese women. Efforts to reduce inequalities in neighborhood SES may represent an important strategy in improving the health status of individuals.

Acknowledgments

The authors thank Keika Mine, Yoko Hosoi, Mami Itabashi, Tomono Yahata, Asako Ishiwaki, and Kyoko Saito (National Institute of Health and Nutrition) for data collection.

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Appendix

The members of the Japan Dietetic Students' Study for Nutrition and Biomarkers Group (in addition to the authors) are as follows: Mitsuyo Yamasaki, Yuko Hisatomi, Junko Soezima, and Kazumi Takedomi (Nishikyushu University); Toshiyuki Kohri and Naoko Kaba (Kinki University); Etsuko Uneoka (Otemae College of Nutrition); Hitomi Hayabuchi and Yoko Umeki (Fukuoka Women's University); Keiko Baba and Maiko Suzuki (Mie Chukyo University Junior College); Reiko Watanabe and Kanako Muramatsu (University of Niigata Prefecture); Kazuko Ohki, Seigo Shiga, Hidemichi Ebisawa, and Masako Fuwa (Showa Women's University); Tomoko Watanabe, Ayuho Suzuki, and Fumiyo Kudo (Chiba Prefectural University of Health Science); Katsumi Shibata, Tsutomu Fukuwatari, and Junko Hirose (The University of Shiga Prefecture); Toru Takahashi and Masako Kato (Mimasaka University); Toshinao Goda and Yoko Ichikawa (University of Shizuoka); Junko Suzuki, Yoko Niida, Satomi Morohashi, Chiaki Shimizu, and Naomi Takeuchi (Hokkaido Bunkyo University); Jun Oka and Tomoko Ide (Tokyo Kasei University); and Yoshiko Sugiyama and Mika Furuki (Minamikyushu University).

準体重群 (BMI：18～24) では7～10kgとされている[8]．またHyttenらの報告によると健康初妊婦の妊娠時の平均体重増加量は12.5kgとしている[3]．米国のNational Academy of Scienceの医学部門における妊娠時の体重に関する勧告[9]では，やせには12.5～18kg，正常妊婦には11.5～16kg，肥満に対しては7～11.5kgが妊娠時の適正な体重増加量としている．ここでいうやせ・正常・肥満はbody mass index (BMI) でそれぞれ19.8未満，19.8～26，26以上で定義している．またBMIが29を超える場合は，少なくとも6kg以上の体重増加を必要としている．American College of Obstetricians and Gynecologists[10]もこのガイドラインを用いている．

［杉山　隆］

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4.3　高齢者の栄養

栄養を考える上で重要な高齢者の特徴は，①加齢に伴う身体の機能および形態の変化，②個人差の大きさ，③疾病もしくは障害の保有率である．これらの特徴によって，高齢者では栄養の摂取や身体活動の低下，代謝の変化，疾病等による身体状況の悪化が見られ，一般に栄養障害を来たしやすい．高齢者の栄養状態・栄養必要量の評価に関しては，若年者よりも相応の注意を払うことが必要である．

1)　加齢による消化・吸収・代謝の変化

加齢により基礎代謝は低下するが，中高齢期での低下はそれ程著しくはなく，身体活動が活発な高齢者では加齢に伴う変化は非常に小さいという報告がある[1]．

一方，高齢者では委縮性胃炎のために胃酸分泌が減少している．そのため小腸において細菌の過増殖が起こり，小腸からの栄養素吸収が低下するという報告があり[2]，これが低栄養を引き起こす要因のひとつと考えられてきた．

炭水化物，脂質，たんぱく質の加齢による吸収率の低下は明らかではないが，炭水化物の代謝から見ると，加齢に伴いインスリン分泌が低下し，食後血糖値が上昇しやすくなる．また，骨格筋量が減少し，脂肪の割合が増加することにより，インスリン抵抗性の増大や骨格筋でのたんぱく代謝の低下が見られる．

他の栄養素では，胃酸および内因子の分泌減少により，ビタミンB_{12}の消化・吸収が低下すると報告されている[3]．カルシウムの腸管からの吸収率は若年者より低いことが知られてお

り．これは高齢者のビタミンDの栄養状態の低下や活性化ビタミンDの作用の低下などによる．

以上のように，さまざまな栄養素の消化・吸収・代謝が，加齢による影響を受ける可能性が指摘されている．しかしながら，一般に消化管の機能，形態は他の臓器ほどは加齢の影響を受けないものと考えられている．食道や胃の運動は高齢者では低下しているとされるが，胃の加齢変化と捉えられていた萎縮性胃炎や胃酸分泌の低下は，近年，加齢に伴って増加する *Helicobacter pylori* 感染によるものである可能性が示された[4]．少なくともヒトの小腸は形態的には加齢の影響をあまり受けないため[5]，栄養素の吸収に関しても，小腸の機能・形態の変化による影響を大きく受けることはないと考えられる．今のところ，加齢に伴う腸管からの栄養吸収障害が，高齢者の低栄養の主たる原因であるとの根拠はない．

2) 高齢者の栄養摂取量

高齢者の栄養摂取量を国民健康・栄養調査で見ると，エネルギーや脂質の摂取量は70歳未満の成人より平均的に下がっているが，他の栄養素に関しては，成人より摂取量が特に少ないという傾向は明らかではない(図3－3)．また，摂取量のばらつきが70歳以上で特に大きくなるという傾向も見られなかった．各栄養素の摂取量を日本人の食事摂取基準（2010年版）の高齢者（70歳以上）の基準値と比較した場合，カルシウム，亜鉛，ビタミンB_1などは，推定平均必要量未満しか摂取していない人の割合が男女とも50%を超えており，不足しやすい栄養素ということができる．

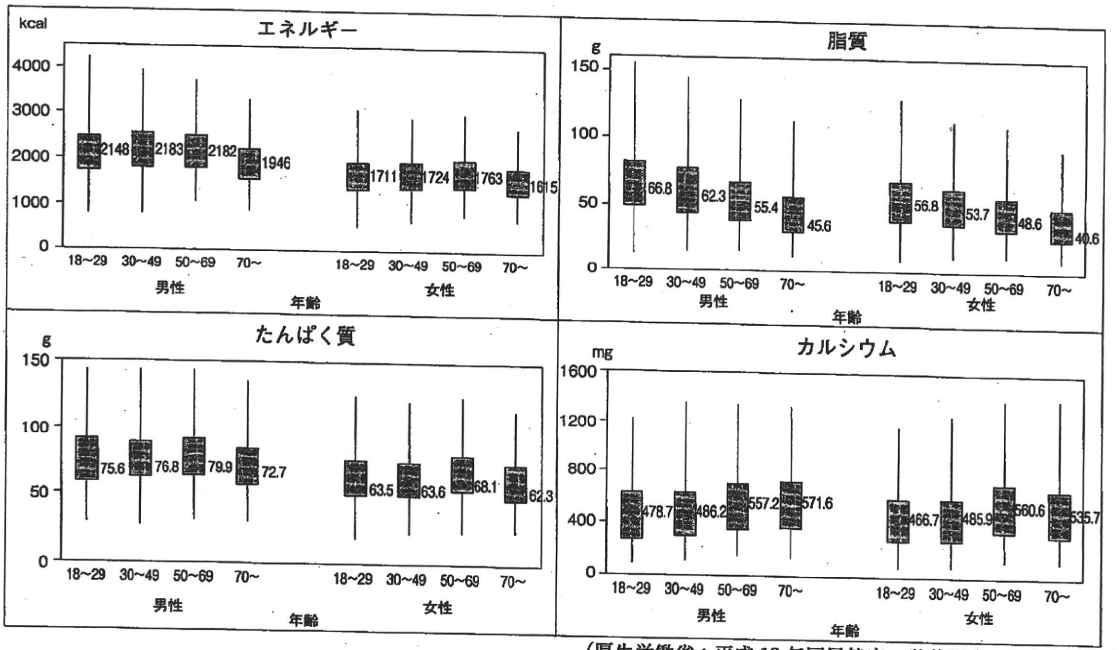
国民健康･栄養調査では，高齢者でも肥満(図3－4)，メタボリックシンドロームや糖尿病が高率に認められ，なおかつ増加傾向にある．調査の回答者は自立した健康な高齢者が主であると考えられ，このような自立高齢者では，過栄養が問題となってきていることが明らかである．上述したように，加齢に伴い筋肉や骨などの除脂肪体重（lean body mass）が減少し，脂肪組織の割合が増えるため，質的には肥満状態に向かいやすい．生活習慣病を予防するためには，青壮年期からの運動習慣による筋量・骨量の維持とともに，過不足のない適切な栄養摂取が重要である．

3) 有病者，要介護者の栄養状態

高齢者は何らかの疾患を有する率が高く，70歳以上では半数以上が病気やけが等で何らかの自覚症状がある（有訴者率＝520人/人口千人当たり）．また，70歳以上では人口の4.4%が入院していると推定される（入院受療率＝4,400人/人口10万人当たり）．介護保険の実施から見ると，65歳以上高齢者の16%が要介護(要支援)認定を受けており，介護サービスの利用者は350万人に上る．健康で自立した高齢者では個人差はそれほど大きくなく，低栄養状態もほとんど見られないが，高齢者全体で見ると，有病者や要介護者が大きな割合で存在している．施設居住者は，自立した高齢者よりも身体活動量や基礎代謝量が少なく[6]，経口から十分な栄養が摂取できずに低栄養状態にある人も少なくない．食事摂取量の不足による低栄養（protein-energy malnutrition：PEM）は，加齢に伴う筋肉量の減少と筋力の低下を加速し，sarcopeniaとよばれる状態を引き起こす．これは，高齢者の骨折や転倒，自立障害の大きな原因となっている．

4) 高齢者の栄養評価

高齢者，特に有病者や要介護者への適切な栄養対策を考える上では，栄養状態の正確な評価が必要不可欠である．栄養状態の評価は，①身体組成の測定，②血液データの測定，③食事摂



（厚生労働省：平成18年国民健康・栄養調査より作成）

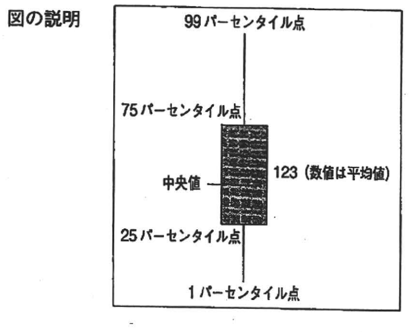
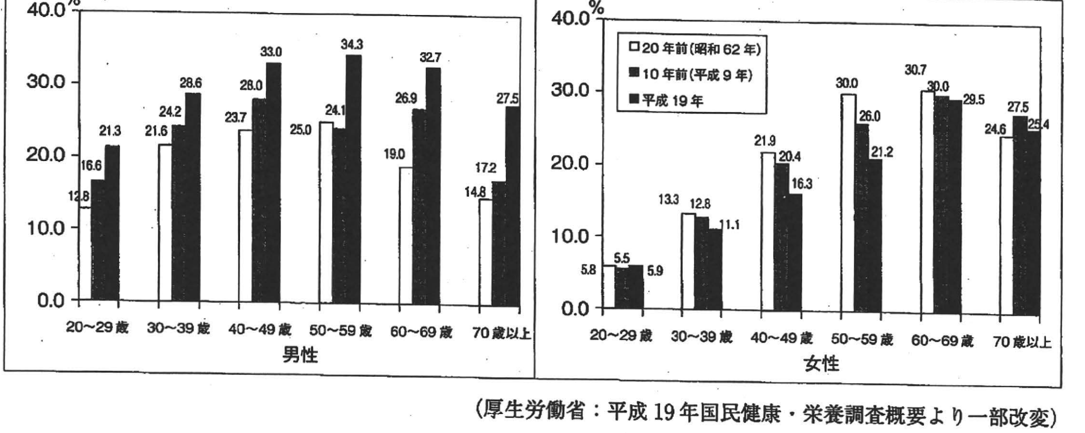


図３－３　年齢別栄養摂取量



（厚生労働省：平成19年国民健康・栄養調査概要より一部改変）

図３－４　年齢別肥満者（BMI ≧ 25）の割合