表３　リン摂取量と血清無機リンなどリン関連項目（研究２）

		平均	標準偏差	最小値	最大値
リン摂取量	mg/day	960	288	332	1945
血清無機リン	mg/dL	3.84	0.38	2.5	5.0
血清カルシウム	mg/dL	9.70	0.30	8.5	10.6
尿中無機リン	mg/dL	74.4	31.8	21.2	169.5
尿中カルシウム	mg/dL	11.7	5.9	0.3	33.9
尿中無機リン	mg/day	626	161	127	1121
尿中カルシウム	mg/day	102	49	3.5	325

対象者は 238 名

尿中無機リン、カルシウム排泄量は尿中無機リン、カルシウム濃度×尿量で算出

表４　リン摂取量と関連項目との相関（研究２）

	相関係数	
血清無機リン	0.076	NS
血清カルシウム	0.011	NS
尿中無機リン濃度	0.019	NS
尿中カルシウム濃度	-0.060	NS
尿中無機リン排泄量	0.223	p<0.01
尿中カルシウム排泄量	0.029	NS

対象者数は 238 名

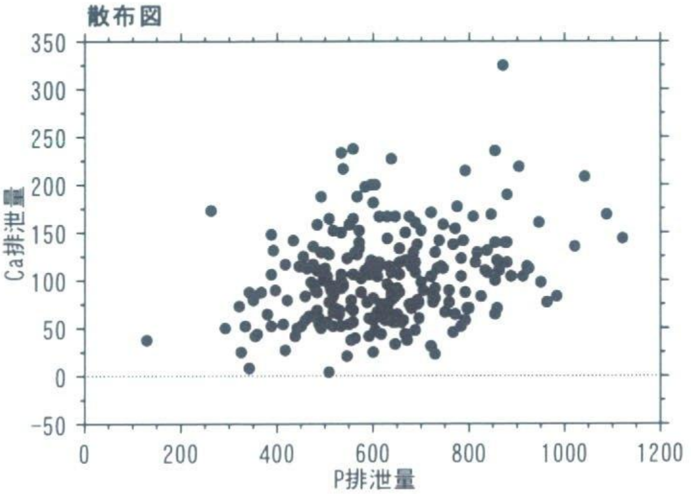

図１　尿中リン排泄量とカルシウム排泄量の関係

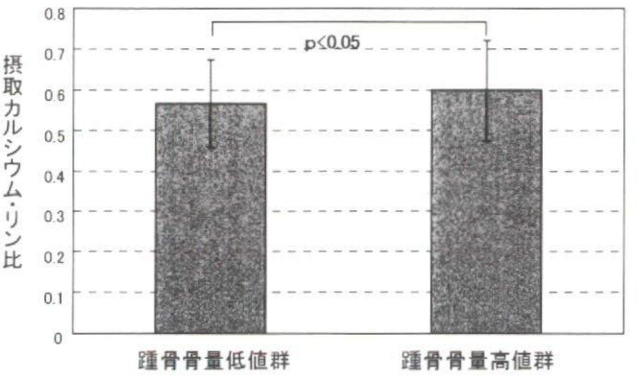

図2　踵骨骨量別のカルシウム・リン摂取量比

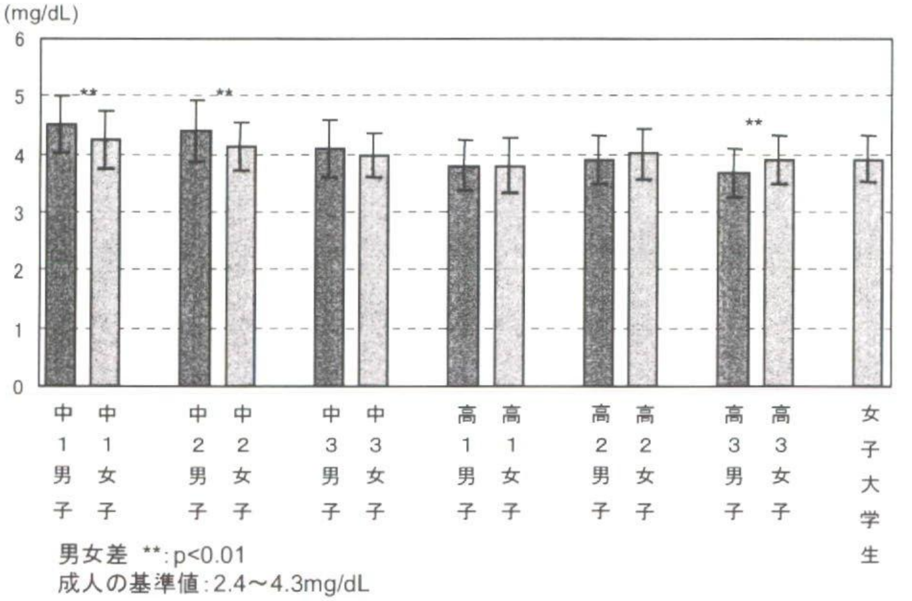

図3　血清無機リンの性別・年代別変動

食品中ヨウ素含有量の分析調査

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研究要旨
日本人が比較的多く食べる食品中ヨウ素含有量を測定すること、また佐々木らの自記式食事歴法質問票にて日本人のヨウ素摂取量を推定できるようにするために、食品中ヨウ素含有量のデータベース作成を目的に本研究を実施した。市販の食品約150検体をスーパーマーケット、コンビニエンスストア等で購入し、食品中に含まれるヨウ素を分析した。穀類、糖類、野菜類、果物類、乳類、肉類中のヨウ素含有量は、検出限界以下（<0.05mg/100g）であった。海藻類、和風調味料・だし、ヨード卵中に高濃度のヨウ素が含まれており、食事調査の際には、これらの食品、料理を詳細に調べる必要がある。

A．研究の背景ならびに目的

食材ではもちろんのこと、だし等で海産物を多く利用した日本食を多く摂取する日本人は、いままでヨウ素の過剰摂取の例がのぼることはあったが、不足・欠乏は問題視されてこなかった。食品中のヨウ素含有量も過剰摂取に重きを置いていたために、ヨウ素含有量の多い海藻類（昆布、ひじき、わかめなど）のデータが多く散見されるが、食品群別に測定したデータベース作成は、桂と中道(1960)（1, 2）ら以降なされていない。食品摂取形態の多様化、食事の西洋化により、食事内容も40年前とは大きく変化しており、ヨウ素の測定技術も進歩していることから、食事摂取基準を見直す現時点において食品中のヨウ素含有量を網羅的に測定し、データベース化することにより、日本人のヨウ素摂取量を推定することができる。

本研究では、佐々木らの自記式食事歴法質問票（DHQ）より、ヨウ素摂取量を推定することを目的に、食品を選択し、ヨウ素を測定した。また、ヨウ素の多く含まれる海産物は食品そのものだけではなく、それらの戻し汁や抽出後の残物についても詳細に測定した。

1) 桂英輔, 中道律子.日本食品中のヨード量. 栄養と食糧 1960; 12: 342-4.
2)桂英輔, 中道律子.日本食品中のヨード摂取量. 栄養と食糧 1960; 12: 345-7

B. 方法

B-1．食品の購入

市販食品約150サンプルを財団法人日本食品分析センターが、大阪府吹田市近郊のスーパーマーケ

ット、コンビニエンスストア、ファーストフード店で購入した。流動タイプの食品 2 サンプルについては、通信販売にて購入した。

B-2.　試験方法

サンプルのうち、水と親和性の小さいものは、①灰化—ガスクロマトグラフ法により、親和性の大きいものは、②抽出—ガスクロマトグラフ法により試験した。サンプルによっては、①および②の 2 法により試験をした。

① 灰化—ガスクロマトグラフ法

サンプル 1～5g に水酸化ナトリウム溶液を加え混和した後、熱板上で乾燥し、500℃の電気炉中で灰化した。灰を水に溶解し、不溶分をろ別したものを試験溶液とした。

試験溶液中の適量を共栓つき試験管にとり（1+1）硫酸 0.7ml、メチルエチルケトン 1ml 及び 200μg/l 亜硝酸ナトリウム溶液 1ml を加えて混合し、室温で 20 分間放置後、ヘキサン 10ml で抽出し、その 1μl を ECD-ガスクロマトグラフ装置に注入した。別に、ヨウ素標準溶液を共栓付試験管にとり、以下同様に操作し、得られた検量線から、試験溶液中のヨウ素濃度を産出した。

② 抽出—ガスクロマトグラフ法

サンプル約 1～5g にフェロシアン化カリウム溶液*2ml、酢酸亜鉛溶液 2ml および水 20～25ml 加えて振とうした後、ろ紙（No.5A「東洋濾紙株式会社」）を用いてろ過したものを試験溶液とした。（*：タンパク質および脂肪を多く含む場合に加えた。）

試験溶液の適量を共栓付試験管にとり、以下①と同様に操作した。別に、ヨウ素標準溶液を共栓付試験管にとり、以下同様に操作し、得られた権稜線から試験溶液中のヨウ素濃度を産出した。

③ ガスクロマトグラフ測定条件（一例）

・機種：6890N (Agilent Technologies Company)
・検出器：ECD
・カラム：DB-WAX (J&W scientific) φ250μm x 30.0mm, 膜厚 0.25μm
・温度：試料注入口 200℃　検出器 250℃　カラム　45℃（2min 保持)→10℃/min 昇温→150℃（5min 保持）
・注入方法：スプリットレス
・キャリヤーガス流量：ヘリウム 1.1ml/min
・追加ガス流量：窒素 30.0ml/min
・　注入量：1μl

測定法の参考文献

1：栄養表示基準における栄養成分等の分析方法等について（衛新第 13 号）、1999.
2：山野辺秀夫ら .ガスクロマトグラフィーによる食品中のヨウ素の定量法について：東京衛研年報 1980 ; 137-141.
3：Makker HJ. Gas-liquid Chromatographic determination of total inorganic Iodine in milk. J of The AOAC 1977 ; 60(6) : 1307-09.

B-3.　添加回収試験

何点かのサンプルについては、サンプルにヨウ素標準溶液*を添加して、その回収率を調べた。
*：標準試料（環境標準試料 NIES CRM No.9 ホンダワラ：独立行政法人　国立環境研究所）

C.　結果

食品中ヨウ素の分析結果を表 1 に示した。食品群、食品番号は、五訂食品成分表の分類に基づいている。食品単位でないもの、栄養補助食品など

の五訂食品成分表では示すことのできないものは、その他、料理単位として測定結果を掲載した。

穀類、糖類、野菜類、果物類、乳類、肉類中のヨウ素含有量は、検出限界以下（<0.05mg/100g）であった。

藻類、和風だし、鶏卵（ヨード卵）にヨウ素が多く含まれていた。詳細については、表を参照していただきたい。

D. 考察

食品中のヨウ素含有量を網羅的に調べた結果、やはり、海藻類、昆布だし、かつおだし等の和風調味料、ヨード卵にヨウ素が多く含まれていた。食事からのヨウ素摂取量を推定する場合、これらの食品を詳細に調べる必要がある。また、海藻類を水に浸しておくことで、含まれているヨウ素多くが水に移行する（昆布：192mg/100g→抽出液241mg/100g、ひじき：50.3mg/100g→戻し汁20.2mg/100g）。この結果から、こんぶ、ひじきそのものの摂取量を調査すると同時に、抽出液・だし汁も料理中にふくまれているかどうかの詳細調査が必要であることが示唆された。

卵に関しては、ヨード卵であるかどうかのチェックが必要である。

さらに、サプリメント中にヨウ素が含まれている可能性もあるので、サプリメントを摂取しているかどうかに加えて、それに含まれる栄養成分が記載してあるものを調査の際に持参させる配慮が必要であろう。

最近は、外食、コンビニ弁当などが急速に普及しており、個々の料理にどんな食材がどのくらい使用されているのかがわかりづらくなっており、食品毎の摂取量を調査することが困難になってきている。また、料理によるヨウ素の存在形態が異なることを考慮すると、今後は、個々の食品についてのヨウ素含有量を測定するのではなく、口に入る状態つまり、調理後の料理単位中のヨウ素含有量を測定していく必要があると考える。

E. 結論

ヨウ素の摂取源は、藻類を含む日本食由来であり、食事調査の際には、これらの食品・およびその食品の抽出液の調査を実施する必要がある。

F. 研究発表

1. 論文発表

なし

2. 学会発表

なし

表 1.　食品中ヨウ素含有量

食品群	食品番号	食品名	ヨウ素 (mg/100g)	前処理方法	備考1	備考2
1 穀類						
	1015	薄力粉・1等	<0.05	抽出/灰化		
	1056	即席中華めん-油揚げ味付け	<0.05	灰化/抽出	インスタントラーメン(チキンスープ)	
	1056	即席中華めん-油揚げ味付け	<0.05	灰化/抽出	インスタントラーメン(みそ味)	
	1062	和風・スナックめんー油揚げ	0.63	抽出	カップうどん、そのまま分析	
	1080	こめ・玄米(水稲)	<0.05	灰化		
	1083	こめ・精米(水稲)	<0.05	灰化		
2 芋類						
	2004	板こんにゃく(生いもこんにゃく)	0.30	灰化	こんにゃく(黒)	
	2005	こんにゃく・しらたき	<0.05	抽出	こんにゃく(白)	
	2008	さつまいもー焼き	<0.05	灰化	皮含めた。両端5mm程度除く。	
3 糖類						
	3003	車糖・上白糖	<0.05	灰化		
	3004	車糖・三温糖	<0.05	灰化		
4 豆類						
	4030	きな粉・脱皮大豆	<0.05	灰化		
	4033	絹ごし豆腐	<0.05	抽出		
	4053	豆乳・調製豆乳	<0.05	抽出		
	4047	挽きわり納豆	<0.05	灰化		
5 種実類						
	5018	ごまーいり	<0.05	灰化		
	6061	キャベツ・結球葉ー生	<0.05	灰化		
	6205	にがうり・果実ー生	<0.05	灰化	ゴーヤ	
	6086	こまつな・葉ー生	<0.05	灰化		
	6134	だいこん・根、皮むきー生	<0.05	抽出		
	6153	たまねぎ・りん茎ー生	<0.05	灰化		
	6183	トマト・ミニトマト・果実ー生	<0.05	抽出		
	6186.1	トマト・缶詰・ミックスジュース(食塩無添加)	<0.05	抽出	野菜ジュース	
	6214	にんじん・根、皮むきー生	<0.05	灰化		
	6267.2	ほうれんそう・葉ー生(冬採り)	<0.05	灰化		
	6291	もやし・りょくとうもやしー生	<0.05	灰化/抽出		
	6293.1	モロヘイヤ・茎葉ー生(木質茎つき)	<0.05	抽出		
7 果物						
	7049	かき・甘がきー生	<0.05	灰化		
	7062	グレープフルーツ・砂じょうー生	<0.05	抽出		
	7077	すいかー生	<0.05	灰化		
	7107	バナナー生	<0.05	抽出		
	7029	温州みかん・砂じょう・普通ー生	<0.05	抽出		
	7148	りんごー生	<0.05	抽出		
	7014	いちご・ジャム・低糖度	<0.05	抽出		
	7064	グレープフルーツ・果実飲料・濃縮還元ジュース	<0.05	抽出		
8 きのこ類						
	8011	しいたけ・生しいたけー生	<0.05	灰化		
9 藻類						
	9002	あおのりー素干し	26.1	灰化		
	9002	あおのりー素干し	2.59	抽出		
	9004	あまのり・焼きのり	1.19	灰化		
	9017	こんぶ・まこんぶー素干し	225	灰化	おしゃぶり昆布	
	9017	こんぶ・まこんぶー素干し(だし用)	192	灰化	真昆布、そのもの	
	9017	こんぶ・まこんぶー素干し、抽出液	2.54, (241)	抽出	*1Lの水中にコンブ(約10 g)を入れ, 沸騰直前まで中火で煮出した後, コンブを取り出した液について試験した。但し, ( )内は, コンブ重量当たりの値。	
	9017	こんぶ・まこんぶー素干し、抽出後の昆布	3.03	灰化		
	9028	てんぐさ・寒天	0.23	灰化	粉末	
	9031	ひじき・ほしひじき	46.2	灰化	調理前(乾燥)、国産(九州)	
	9031	ひじき ・ ほしひじき	53.8	灰化	調理前(乾燥)、中国産	
	9031	ひじき・ほしひじき、戻し汁	20.2	抽出	上記ひじき(乾燥)40gを1Lの水に浸し、その戻し汁を測定した。値は、ひじき(乾)重量あたり。	
	9031	ひじき・ほしひじき、調理後	0.89	灰化	調理後(お惣菜)	
	9033	ひとえぐさ・つくだ煮	0.07	抽出		
	9037	もずく・おきなわもずく・塩蔵ー塩抜き	0.18	灰化	三杯酢除く	
	9037	もずく・おきなわもずく・塩蔵ー塩抜き	<0.05	灰化/抽出	たれ, 液体を除く	

（続き）

食品群	食品番号	食品名	ヨウ素 (mg/100g)	前処理方法	備考1	備考2
9 藻類						
	9040	乾燥わかめー素干し	4.11	灰化		
	9045	湯通し塩蔵わかめー塩抜き	0.96	灰化	ﾎﾞｲﾙ塩蔵わかめ	
10 魚介類						
	10006	あじ・まあじ・開き干しー生	<0.05	灰化/抽出	頭・皮・骨・ﾋﾚを除く	
	10015	あなごー生	<0.05	灰化	頭・尾を除く	
	10045	いわし・かたくちいわし・煮干し	0.23	抽出	乾ちりめん	
	10070	うなぎーかば焼	0.07	灰化	ﾀﾚ・ｻﾝｼｮｳを含めた	
	10092	かつお・削り節	<0.05	抽出		
	10169	さめ・ふかひれ	0.08	抽出	中華スープ（フカヒレ）	
	10134	しろさけー生（切り身）	<0.05	抽出		
	10154	さば・まさばー生	<0.05	抽出		
	10173	さんまー生	<0.05	抽出	皮含めた。骨・内臓除く。	
	10173	さんまー生(内臓)	<0.05	抽出		
	10180	ししゃもー生干しー生	<0.05	抽出		
	10193	まだいー養殖ー生	<0.05	灰化/抽出		
	10202	すけとうだら・たらこー生	<0.05	灰化		
	10205	まだらー生（切り身）	0.51	抽出	皮除く	
	10252	まぐろ・きはだー生（切り身）	<0.05	灰化		
	10263	まぐろ・缶詰ー油漬、ﾌﾚｰｸ・ﾗｲﾄ	0.61	抽出	ツナ缶	
	10292	かき・養殖ー生	0.08	抽出	水除く	
	10297	しじみー生	<0.05	抽出	いりこだしと味噌を使用して味噌汁を調製。水600mlとだし4g。	回収試験 105%
	10329	えび・ブラックタイガー・養殖ー生	<0.05	抽出		
	10358	いか・塩辛	<0.05	抽出		
	10362	たこ・まだこーゆで	<0.05	抽出		
	10379	蒸しかまぼこ	0.54	抽出		
11 肉類						
	11060	輸入牛・かた・脂身つきー生	<0.05	灰化/抽出		
	11089	うし・ひき肉ー生	<0.05	灰化/抽出		
	11119	ぶた・大型種・かたﾛｰｽ・脂身つきー生	<0.05	灰化		
	11163	ぶた・ひき肉ー生	<0.05	灰化/抽出		
	11224	にわとり・若鶏・もも、皮なし-生	<0.05	灰化		
	11232	にわとり・肝臓ー生	<0.05	灰化/抽出		
12 卵類						
	12004	鶏卵・全卵ー生	<0.05	灰化	普通	
	12004	鶏卵・全卵ー生	1.09	灰化	ﾖｰﾄﾞ卵	
	12004	鶏卵・全卵ー生	2.00	抽出	ﾖｰﾄﾞ卵	
	12005	鶏卵・全卵ーゆで	1.21	抽出	上記ヨード卵を15分間茹でた。	
13 乳類						
	13003	普通牛乳	<0.05	抽出		
	13003	普通牛乳	<0.05	抽出		
	13003	普通牛乳	<0.05	抽出		
	13004	加工乳・濃厚	<0.05	抽出		
	13040	プロセスチーズ	<0.05	灰化		
15 菓子類						
	15033	まんじゅう・蒸しまんじゅう	<0.05	灰化		
	15040	ようかん・蒸しようかん	<0.05	灰化/抽出	羊かん（寒天入り）	
	15069	あんパン	<0.05	灰化		
	15087	ゼリー・オレンジ	<0.05	抽出	こんにゃくｾﾞﾘｰ	
	15087	ゼリー・オレンジ	<0.05	灰化/抽出	ｾﾞﾘｰ(寒天)	
	15089	ゼリー・ミルク	<0.05	抽出	杏仁豆腐	
	15103	ポテトチップス・ポテトチップス	0.19	抽出	ﾎﾟﾃﾄﾁｯﾌﾟｽ（和風味）	
	15116	ミルクチョコレート	<0.05	灰化		
16 嗜好飲料類						
	16006	ビール・淡色	<0.05	抽出		
	16037	せん茶・浸出液	<0.05	抽出		
	16037	せん茶・浸出液	<0.05	抽出		
	16037	せん茶・浸出液	<0.05	抽出		回収率99%
	16052	炭酸飲料	<0.05	抽出	特定保健用食品、ﾌｧｲﾌﾞﾐﾆ	
17 調味料および香辛料類						
	17002	ウスターソース・中濃ソース	<0.05	抽出		
	17007	こいくちしょうゆ	<0.05	抽出		

（続き）

食品群	食品番号	食品名	ヨウ素 (mg/100g)	前処理方法	備考1	備考2
17 調味料および香辛料類						
	17012	食塩	<0.05	抽出	天然塩（伯方の塩）	
	17020	昆布だし	2.76	抽出	3倍濃縮ﾀｲﾌﾟ（液体）	
	17020	昆布だし	1.97	抽出	8倍濃縮ﾀｲﾌﾟ（液体）	
	17023	煮干しだし	<0.05	抽出	いりこだし	
	17028	顆粒風味調味料	1.91	抽出	関西風うどんつゆの素、顆粒	
	17028	顆粒風味調味料	10.5	灰化/抽出	だしの素（こんぶ）、顆粒	
	17039	ドレッシングタイプ和風調味料	5.75	抽出	和風・こんぶｴｷｽ入り	
	17043	マヨネーズ・卵黄型	<0.05	灰化/抽出		
	17045	米みそ・淡色辛みそ	<0.05	抽出		
	17045	米みそ・淡色辛みそ	<0.05	抽出		
	17050	即席みそ・ペーストタイプ	<0.05	抽出	ｲﾝｽﾀﾝﾄ味噌汁（いりこだし）	
	17050	即席みそ・ペーストタイプ	1.37	抽出	ｲﾝｽﾀﾝﾄ味噌汁（煮干だし）、調理前	
	17050	即席みそ・ペーストタイプ	0.18	抽出	ｲﾝｽﾀﾝﾄ味噌汁（煮干だし）、調理後	
	17050	即席みそ・ペーストタイプ	0.58	抽出	ｲﾝｽﾀﾝﾄ味噌汁、非調理	
18 調理加工食品類						
	18002	ぎょうざー冷凍	<0.05	灰化	冷凍のまま	
	18002	ぎょうざー冷凍	<0.05	灰化	調理済、たれ，ラー油を除く	
	18001	カレー・ビーフ、レトルトパウチ	<0.05	灰化		
その他（栄養補助食品、飲料など）						
		ｽﾎﾟｰﾂ飲料	<0.05	抽出	ｱﾐﾉﾊﾞｲﾀﾙ	
		ﾐﾈﾗﾙｳｫｰﾀｰ	<0.05	抽出	evian	
		栄養ﾄﾞﾘﾝｸ	<0.05	抽出	ﾘﾎﾟﾋﾞﾀﾝD	
		栄養補助食品	<0.05	灰化	ｶﾛﾘｰﾒｲﾄ（ﾌﾟﾚｰﾝ）	
		栄養補助食品	<0.05	灰化/抽出	ｶﾛﾘｰﾒｲﾄ（ﾁｮｺ味）	
		栄養補助食品（錠剤）	<0.05	灰化	うこん	
		栄養補助食品（錠剤）	4.87	抽出	ﾏﾙﾁﾐﾈﾗﾙ、表示：50□g/6粒（1粒：272mg）	
		栄養調整食（流動ﾀｲﾌﾟ）	0.02	抽出	日清ｷｮｰﾘﾝ製薬（ﾗｲﾌﾛﾝQL125ml），表示：8.5□g/62.5ml	回収率101%
		栄養補助食（食品流動食）	0.03	抽出	ｷｭｰﾋﾟｰ（ｼﾞｬﾌﾈK4-S300ml），表示：15□g/100ml	回収率89%
料理単位						
	2004	おでん・板こんにゃく（生いもこんにゃく）	<0.05	抽出	1食重量 72g	
	4041	おでん・がんもどき	<0.05	抽出	1食重量 88g	
	1111	おにぎり（鮭）	<0.05	灰化	めし、鮭、のり	
	1111	おにぎり（昆布佃煮）	0.13	灰化	めし、こんぶ、のり	
	1111	おにぎり（わかめごはん）	0.10	抽出	わかめごはん1食重量 116g	
		調理パン（ﾂﾅﾏﾖﾊﾟﾝ）	<0.05	灰化	食ﾊﾟﾝ、ﾂﾅ缶、ﾏﾖﾈｰｽﾞ	
		ｻﾗﾀﾞ	<0.05	抽出	1食重量 115g、ｶｯﾌﾟｻﾗﾀﾞ	
		あさりと山菜の和風ﾊﾟｽﾀ	<0.05	抽出	1食重量 302g	
		ﾊﾝﾊﾞｰｶﾞｰ	<0.05	抽出	1食重量 100g	
		ﾊﾝﾊﾞｰｶﾞｰ（ｴﾋﾞﾌｨﾚｵ）	<0.05	抽出	1食重量 156g	
		弁当（ﾎﾞﾘｭｰﾑのり弁当）	<0.05	抽出	1食重量 465g	
		弁当（天然紅鮭弁当）	0.06	抽出	1食重量 400g	鮭の骨除く
		弁当（帆立ご飯幕の内弁当）	0.17	抽出	1食重量 358g	鮭の骨除く
		お好み焼き（冷凍）	0.19	灰化	冷凍	
		寿司（太巻寿司）	<0.05	抽出	1食重量 254g	
		ふりかけ	<0.05	灰化	のり、たまご、ごま等	

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分担研究報告書

『日本人の食事摂取基準（2005年版）』の部分英訳

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研究要旨

わが国では、近年は５年ごとに食事摂取基準（旧称：栄養所要量）を厚生労働省から発表されてきた。しかし、和文のみによる発表であり、非日本語（たとえば、英語）の対訳はいままで存在しなかった。そこで、今回の改正で新しく加えられた部分である『総論』、その概念が大きく改定された『エネルギー』、そして、全体の要約に当たる『概要』の英語訳を試みた。

この英語訳は、類似の食習慣や栄養上の問題をもつアジア諸国の食事摂取基準（旧称：栄養所要量）の作成、改定の一助となることが期待される。

A. 研究の背景ならびに目的

わが国では、近年は５年ごとに食事摂取基準（旧称：栄養所要量）を厚生労働省から発表されてきた。しかし、和文のみによる発表であり、非日本語（たとえば、英語）の対訳はいままで存在しなかった。そこで、今回の改正で新しく加えられた部分である『総論』、その概念が大きく改定された『エネルギー』、そして、全体の要約に当たる『概要』の英語訳を試みた。

B. 方法

B-1-1. 訳出方法

『総論』、『エネルギー』、『概要』について、医学英語翻訳の専門家が下訳を行い、その原稿を、英語に堪能な管理栄養士が修正を行い、訳出の各段階で、佐々木が原稿のチェックを行った。

C. 結果

訳出結果は添付資料を参照されたい。

D. 考察

訳出は予想よりも困難であった。その理由として、１）日本人の食事摂取基準（旧称：栄養所要量）の英訳が初めての作業であり、参考とすべき前例がなかったこと、２）専門用語について、日本語と英語間での対応がじゅうぶんに確立していないものがあったが理由と考えられた。

しかし、今回の訳出は全体の一部に留めたが、可能ならば全訳を行うことができれば、更に参加資料としての価値は高くなるだろう。

また、可能であれば、次回の改定より、日本語（本文）と同時に英語訳を発表することが望まれる。日本人の食事摂取基準（2005年版）』の英語訳版は、食のグローバル化や、栄養が関連する健康問題（特に、生活習慣病）のグローバル化が進む中で、近隣諸国（東アジアならびに東南アジア）のこの分野の発展に大きく寄与することが期待される。

F. 研究発表

1. 論文発表　なし

2. 学会発表　なし

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The influence of age and body mass index on relative accuracy of energy intake among Japanese adults

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Abstract

Objective: To examine relationships between the ratio of energy intake to basal metabolic rate (EI/BMR) and age and body mass index (BMI) among Japanese adults.
Design: Energy intake was assessed by 4-day semi-weighed diet records in each of four seasons (16 days in total). The EI/BMR ratio was calculated from reported energy intake and estimated basal metabolic rate as an indicator of reporting accuracy.
Setting: Residents in three areas in Japan, namely Osaka (urban), Nagano (rural inland) and Tottori (rural coastal).
Subjects: One hundred and eighty-three healthy Japanese men and women aged ≥ 30 years.
Results: The oldest age group (≥ 60 years) had higher EI/BMR values than the youngest age group (30–39 years) in both sexes (1.74 vs. 1.37 for men; 1.65 vs. 1.43 for women). In multiple regression analyses, age correlated positively (partial correlation coefficient, $\beta = 0.012$, $P < 0.001$ for men; $\beta = 0.011$, $P < 0.001$ for women) and BMI correlated negatively ($\beta = -0.031$, $P < 0.001$ for men; $\beta = -0.025$, $P < 0.01$ for women) with EI/BMR.
Conclusion: Age and BMI may influence the relative accuracy of energy intake among Japanese adults.

Keywords
Energy intake
Underreporting
Age
Body mass index
Japanese adults

Reliable dietary information plays a critical role in many aspects of human nutrition. Investigators have often relied on self-reported dietary data assessed by diet records, 24-hour dietary recalls and food-frequency questionnaires to interpret the associations between diet and disease. However, the results of various studies applying different assessment methods and investigating different populations have shown common problems such as reporting bias[1,2]. In particular, underreporting of energy intake is a serious threat to the validity of self-reported dietary assessment data. Studies using the doubly labelled water technique as an external biomarker of energy intake not only reveal underreporting of energy intake, but also identify the subject characteristics and factors associated with underreporting[3,4]. Moreover, other studies using the ratio of energy intake to basal metabolic rate (EI/BMR) as an alternative approach to identify the low energy reporters have shown similar results[5,6].

Most studies found a higher proportion of underreporting among women and older subjects[7,8]. Moreover, underreporting of energy intake was common among obese subjects[9–11], but was also observed in non-obese subjects[12,13]. Other factors such as body image, health consciousness, social desirability, educational level and smoking status also affected reporting accuracy[2,14,15]. However, all of these studies were conducted in Western countries. The only study conducted in Japan showed a significantly negative correlation between BMI and EI/BMR among women aged 18–20 years[16]. Thus the purpose of the present study was to examine the relative accuracy of self-reported energy intake among various age ranges in the Japanese population.

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Subjects and methods

Subjects

We selected three areas which have different geographical conditions in Japan: Osaka (urban), Nagano (rural inland) and Tottori (rural coastal). We invited 32 healthy married women aged 30–69 years from each of the three areas to distribute eight women equally in each age class of 30–39, 40–49, 50–59 and 60–69 years. The total number of women recruited was 96. Their husbands (aged 31–76 years) were also invited to participate in the study. None of the subjects was currently receiving or had recently received diet counselling from a doctor or dietitian, nor had a history of educational hospitalisation for diabetes. The subjects were not randomly sampled but asked by local study staff to participate in the study. Here, subject recruitment was continued until a sufficient number of subjects was obtained. Prior to the study, we held group orientations for the subjects where we explained the study purposes and protocol. All subjects giving written informed consent were finally considered eligible for the study.

Dietary assessment

The subjects completed 4-day semi-weighed diet records four times at 3-month intervals from November 2002 to August 2003. Dietary intake was assessed from four randomly assigned days, including one weekend day and three weekdays. A digital scale (Tanita KD-173; $\pm$ 2 g precision for 0–250 g and $\pm$4 g precision for 250–1000 g) was given to each couple to weigh all the foods eaten. When measurement was difficult, e.g. when eating out, we instructed them to record in as much detail as possible the size and quantity of foods they ate. For each recording day, the subjects were asked to fax the completed forms to the local staff (dietitians). The study staff checked the submitted forms and asked the subjects to add and/or modify the records as necessary by telephone or fax. In some cases, the responses were handed directly to the study staff rather than faxed.

All the collected diet records were checked by trained dietitians in each local centre and then in the study centre. The diet records were analysed for nutrient intake by trained dietitians using the food composition table of Japanese foods, 5th edition[17].

Physical activity level and anthropometric measurements

Physical activity level was obtained from a questionnaire which queried information about each subject's occupation and leisure-time activity. One answer was chosen from four categories, i.e. 'low', 'relatively low', 'moderate' and 'heavy' physical activity level. This classification was referenced to the recommended dietary allowance for Japanese, 6th edition[18]. The gross energy expenditure of each category was considered to require 1.3, 1.5, 1.7 and 1.9 times the BMR, respectively[18]. Therefore, we converted the categorical classification of physical activity level to the ratio of BMR based on above values, and expressed as it as a score for easy interpretation.

Body weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, with subjects wearing light clothing and no shoes. BMI was calculated as body weight (kg) divided by the square of body height (m^2). We classified BMI into four categories: $<18.5\,kg\,m^{-2}$, $18.5–24.9\,kg\,m^{-2}$, $25.0–27.9\,kg\,m^{-2}$ and $\geq 28\,kg\,m^{-2}$. Because the proportion of obese subjects (BMI $\geq 30\,kg\,m^{-2}$) was very low ($n = 1$ for men aged 40–49 years; $n = 0$ for women), BMI $\geq 28\,kg\,m^{-2}$ was used as the highest category instead of $\geq 30\,kg\,m^{-2}$ in the present analysis.

BMR was estimated for each subject using formulas based on body weight given by the Food and Agriculture Organization/World Health Organization/United Nations University (FAO/WHO/UNU)[19] as follows.

- Men aged 30–60 years:
  BMR = 0.0485 × bodyweight (kg) + 3.67.
- Men aged >60 years:
  BMR = 0.0565 × bodyweight (kg) + 2.04.
- Women aged 30–60 years:
  BMR = 0.0364 × bodyweight (kg) + 3.47.
- Women aged >60 years:
  BMR = 0.0439 × bodyweight (kg) + 2.49.

Statistical analysis

We included 183 subjects (91 women and 92 men) with complete 16-day diet records living in the Osaka (29 women and 30 men), Nagano (31 women and 31 men) and Tottori (31 women and 31 men) areas in the present analysis.

We calculated the ratio EI/BMR to evaluate the relative accuracy of the reported energy intake. Subjects were allocated into quintiles of EI/BMR to compare 'low energy reporters' with 'high energy reporters'. Low ratios describe subjects reporting comparatively low energy intake relative to their energy requirement. To compare the relative degree of under- and overreporting, we temporarily used the values defined by FAO/WHO/UNU: the minimum survival level of 1.27, the sedentary level for men of 1.55 and women of 1.56, and the maximum sustainable lifestyle level of 2.0–2.4.

Results are given as mean $\pm$ standard deviation. Student's t-test and one-way analysis of variance (ANOVA) were used to test for differences between the groups. When ANOVA indicated a difference among the groups, Dunnett's t-test was applied to compare to the first group as a control. The chi-square test was used to test for proportionate differences between categories. Multivariate evaluation of the simultaneous effects of age, BMI, physical activity level and living area on EI/BMR was performed by a stepwise multiple regression analysis.

We also computed the partial correlation coefficients between each independent variable and EI/BMR adjusting for other independent variables.

All statistical analyses were performed using version 8.2 of the SAS software package (SAS Institute, Inc., Cary, NC, USA). A P-value of <0.05 was considered significant.

Results

Table 1 presents a summary of the physical characteristics of the subjects. Mean age was 52.8 ± 12.1 (range 31–76) years in men and 49.5 ± 11.4 (range 31–69) years in women. Mean values of EI/BMR were not different between sexes (1.55 for men vs. 1.48 for women, $P = 0.12$). Men had a higher BMI (23.3 vs. 22.1 kg m^{-2}, $P < 0.01$) and a higher proportion of overweight (21% vs. 11% for BMI of 25.0–27.9 kg m^{-2} and 10% vs. 2% for BMI ≥28 kg m^{-2}, $P = 0.03$) than women. Men had a higher physical activity level than women (1.48 vs. 1.43, $P = 0.02$), and 38% and 59% of women were classified into low and relatively low physical activity levels, respectively.

Table 2 presents a summary of the physical characteristics of men and women in the four age groups (30–39, 40–49, 50–59 and ≥60 years). Body height decreased with increasing age in both sexes. Body weight and BMR increased as age increased to 40–49 years, and then decreased with increasing age group in both sexes. Although BMI was lowest among the youngest age group in both sexes, a statistically significant difference between age groups was observed only for women ($P < 0.01$). Energy intake was not different between age groups in either sex. On the other hand, mean EI/BMR became significantly higher with increase in age for men

Table 1 Characteristics of study subjects* ($n = 183$)

	Men ($n = 92$)	Women ($n = 91$)	P-value†
Age (years)	52.8 ± 12.1	49.5 ± 11.4	0.06
Body height (cm)	168.0 ± 6.7	155.6 ± 5.9	<0.001
Body weight (kg)	66.2 ± 11.2	53.4 ± 7.2	<0.001
Reported EI (MJ day^{-1})	9.9 ± 1.8	7.8 ± 1.2	<0.001
BMR (MJ day^{-1})‡	6.5 ± 0.9	5.3 ± 0.4	<0.001
EI/BMR	1.55 ± 0.31	1.48 ± 0.24	0.12
BMI (kg m^{-2})	23.3 ± 3.1	22.1 ± 2.6	<0.01
<18.5	4 (4)	6 (7)	0.03§
18.5–24.9	60 (65)	73 (80)	
25.0–27.9	19 (21)	10 (11)	
≥28.0	9 (10)	2 (2)	
Physical activity level	1.48 ± 0.19	1.43 ± 0.11	0.02
Low	37 (40)	35 (38)	<0.001§
Relatively low	36 (39)	54 (59)	
Moderate	11 (12)	2 (2)	
Heavy	8 (9)	0 (0)	

EI – energy intake; BMR – basal metabolic rate; BMI – body mass index.
* Values are expressed as mean ± standard deviation or n (%).
† Significant difference between sexes (t-test).
‡ BMR was calculated using formulas given by the Food and Agriculture Organization/World Health Organization/United Nations University (1985)[19].
§ Significant difference between sexes in all categories (chi-square test).

Table 2 Characteristics of study subjects according to age group in 92 men and 91 women†

	Men					Women				
	30–39 years‡ ($n = 16$)	40–49 years ($n = 24$)	50–59 years ($n = 20$)	≥ 60 years ($n = 32$)	P-value§	30–39 years‡ ($n = 23$)	40–49 years ($n = 22$)	50–59 years ($n = 23$)	≥ 60 years ($n = 23$)	P-value§
Age (years)	36.1 ± 2.2	44.0 ± 3.2	54.8 ± 2.3	66.4 ± 4.6	<0.001	35.7 ± 2.7	43.1 ± 3.2	54.1 ± 2.6	64.7 ± 3.0	<0.001
Body height (cm)	171.8 ± 5.7	171.0 ± 5.8	168.5 ± 7.0	163.7 ± 5.1***	<0.001	158.6 ± 5.7	156.1 ± 5.9	155.6 ± 6.0	152.0 ± 4.0***	<0.01
Body weight (kg)	64.7 ± 11.3	70.1 ± 12.7	69.3 ± 10.7	62.0 ± 9.0	0.02	51.2 ± 6.1	55.3 ± 7.0	55.0 ± 7.8	52.3 ± 7.2	0.14
Reported EI (MJ day^{-1})	9.3 ± 1.2	10.2 ± 2.5	10.5 ± 1.7	9.6 ± 1.3	0.15	7.7 ± 1.3	7.6 ± 1.3	7.9 ± 0.8	7.9 ± 1.2	0.76
BMR (MJ day^{-1})¶	6.8 ± 0.6	7.1 ± 0.6	7.0 ± 0.5	5.5 ± 0.5***	<0.001	5.3 ± 0.2	5.5 ± 0.3	5.5 ± 0.3	4.8 ± 0.3***	<0.001
EI/BMR	1.37 ± 0.21	1.44 ± 0.33	1.50 ± 0.28	1.74 ± 0.25***	<0.001	1.43 ± 0.23	1.39 ± 0.22	1.45 ± 0.14	1.65 ± 0.26***	<0.001
Physical activity level	1.50 ± 0.21	1.51 ± 0.23	1.48 ± 0.17	1.44 ± 0.15	0.59	1.44 ± 0.11	1.44 ± 0.10	1.42 ± 0.10	1.41 ± 0.12	0.82
BMI (kg m^{-2})	21.8 ± 3.0	23.9 ± 3.5	24.3 ± 2.8*	23.1 ± 2.7	0.07	20.3 ± 2.0	22.7 ± 2.9**	22.7 ± 2.2**	22.6 ± 2.7**	<0.01
< 18.5	1 (6)	1 (4)	1 (5)	1 (3)	0.27‖	5 (22)	1 (5)	0 (0)	0 (0)	0.03‖
18.5–24.9	13 (81)	14 (58)	9 (45)	24 (75)		18 (78)	16 (73)	20 (87)	19 (83)	
25.0–27.9	1 (6)	5 (21)	8 (40)	5 (16)		0 (0)	4 (18)	3 (13)	3 (13)	
≥ 28.0	1 (6)	4 (17)	2 (10)	2 (6)		0 (0)	1 (5)	0 (0)	1 (4)	

EI – energy intake; BMR – basal metabolic rate; BMI – body mass index.
† Values are expressed as mean ± standard deviation or n (%).
‡ Significant difference compared with 30–39 year category between age groups within sex (Dunnett's t-test): *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.
§ Significant difference between age groups within sexes (analysis of variance).
¶ BMR was calculated using formulas given by the Food and Agriculture Organization/World Health Organization/United Nations University (1985)[19].
‖ Significant difference between age groups within sexes in all categories (chi-square test).

Table 3 Anthropometric characteristics and lifestyle variables by quartile of EI/BMR ratio†

	Men					Women				
	First quartile ($n=23$)‡	Second quartile ($n=18$)	Third quartile ($n=22$)	Fourth quartile ($n=29$)	*P*-value§	First quartile ($n=22$)‡	Second quartile ($n=28$)	Third quartile ($n=24$)	Fourth quartile ($n=17$)	*P*-value§
EI/BMR	1.17 ± 0.12	1.41 ± 0.05	1.57 ± 0.05	1.90 ± 0.17		1.19 ± 0.09	1.42 ± 0.05	1.58 ± 0.05	1.83 ± 0.14	
Age (years)	44.8 ± 8.8	51.8 ± 10.3	54.6 ± 15.0*	58.3 ± 9.8***	<0.001	44.5 ± 9.8	47.2 ± 9.9	53.1 ± 118*	54.5 ± 12.5*	0.01
Body height (cm)	171.2 ± 4.8	168.8 ± 5.7	168.4 ± 6.7	164.7 ± 7.3**	<0.01	154.0 ± 5.4	156.9 ± 5.7	155.1 ± 5.8	156.0 ± 6.7	0.36
Body weight (kg)	72.0 ± 10.4	68.1 ± 7.4	64.5 ± 12.5	61.6 ± 11.0**	<0.01	53.7 ± 7.4	54.6 ± 6.5	54.1 ± 8.4	50.4 ± 5.5	0.27
EI (MJ day^{-1})	8.3 ± 1.0	9.5 ± 0.6*	9.9 ± 1.6***	11.4 ± 1.7***	<0.001	6.4 ± 0.7	7.6 ± 0.6***	8.3 ± 0.7***	9.1 ± 0.8***	<0.001
BMR (MJ day^{-1})¶	7.1 ± 0.6	6.7 ± 0.6	6.3 ± 0.9**	6.0 ± 0.9***	<0.001	5.4 ± 0.3	5.4 ± 0.3	5.3 ± 0.4	5.0 ± 0.4**	<0.01
Physical activity level	1.47 ± 0.19	1.41 ± 0.12	1.47 ± 0.18	1.53 ± 0.21	0.16	1.41 ± 0.10	1.43 ± 0.11	1.45 ± 0.09	1.42 ± 0.12	0.60
BMI (kg m^{-2})	24.5 ± 3.0	24.0 ± 2.8	22.6 ± 3.2	22.6 ± 3.0	0.06	22.6 ± 2.9	22.2 ± 2.4	22.5 ± 3.0	20.7 ± 1.7	0.11
< 18.5	0 (0)	0 (0)	1 (5)	3 (10)	0.34§	1 (5)	2 (7)	2 (8)	1 (6)	0.82§
18.5–24.9	13 (57)	11 (61)	14 (63)	22 (76)		17 (77)	22 (79)	18 (75)	16 (94)	
25.0–27.9	7 (30)	5 (28)	5 (23)	2 (7)		3 (14)	4 (14)	3 (13)	0 (0)	
≥ 28.0	3 (13)	2 (11)	2 (9)	2 (7)		1 (5)	0 (0)	1 (4)	0 (0)	

EI – energy intake; BMR – basal metabolic rate; BMI – body mass index.
† Values are expressed as mean ± standard deviation or *n* (%).
‡ Significant difference compared with the first quartile of EI/BMR (Dunnett's *t*-test): *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.
§ Significant difference between quartile within sexes (analysis of variance).
¶ BMR was calculated using formulas given by the Food and Agriculture Organization/World Health Organization/United Nations University (1985)[19].

($P<0.001$). Although women aged 40–49 years had the lowest EI/BMR among the women, the trend of the relationship between mean EI/BMR and age was almost the same as that of men ($P<0.001$).

Table 3 presents the mean values of anthropometric characteristics by quartile of EI/BMR. Age and reported energy intake increased significantly with the increase in EI/BMR in both sexes (all $P<0.001$ except for age in women, where $P<0.01$). However, with increasing EI/BMR quartile, body height and body weight decreased significantly in men (both $P<0.01$), as did BMR in both sexes ($P<0.001$ for men, $P<0.01$ for women). BMI was slightly lower in the lowest category of EI/BMR than in the other categories in men, although it was not significant.

Table 4 shows the results of multiple regression analyses with EI/BMR as the dependent variable to examine the prediction for relative accuracy of reporting. For men, age and physical activity level correlated positively (partial regression coefficient, $\beta=0.012$, $P<0.001$ and $\beta=0.377$, $P=0.01$, respectively), and BMI and living area (urban) correlated negatively ($\beta=-0.031$, $P<0.001$ and $\beta=-0.114$, $P=0.045$, respectively), with EI/BMR. On the other hand, age and body height correlated positively ($\beta=0.011$, $P<0.001$ and $\beta=0.011$, $P=0.01$, respectively) and BMI correlated negatively ($\beta=-0.025$, $P<0.01$) with EI/BMR for women. All the independent variables explained 35.7% and 25.7% of the variation in EI/BMR for men and women, respectively.

Figures 1a and 1b show the joint effect of age and BMI on EI/BMR values by cross-classifying subjects by both variables. Compared with subjects classified into the lowest BMI and oldest age group, subjects in the highest

Table 4 Results of stepwise multiple regression analyses with EI/BMR ratio as dependent variable*

Independent variable	β†	SE‡	*P*-value	Partial R^2 (%)§
Men ($n=92$)				
Age (years)	0.012	0.002	<0.001	17.9
BMI (kg m^{-2})	−0.031	0.009	<0.001	9.9
Physical activity level	0.377	0.145	0.01	4.8
Living area (rural coastal area as reference)				
Urban	−0.114	0.056	0.05	3.1
Women ($n=91$)				
Age (years)	0.011	0.002	<0.001	12.1
BMI (kg m^{-2})	−0.025	0.009	0.005	7.0
Body height (cm)	0.011	0.004	0.01	6.6

EI – energy intake; BMR – basal metabolic rate; BMI – body mass index.
*Age (as a continuous variable), BMI (as a continuous variable), height (as a continuous variable), physical activity level (as a continuous variable) and area of living (rural coastal, rural inland, urban) were entered into the model as independent variables.
† Partial regression coefficient; change in the dependent variable related to a one-unit change in the independent variable.
‡ Standard error of the regression coefficient.
§ Explained variance; adjusted R^2 and *P*-values are for independent variables in multiple regression analysis. R^2 value for EI/BMR was 35.7% and 25.7% for men and women, respectively, when all variables were included in the model.

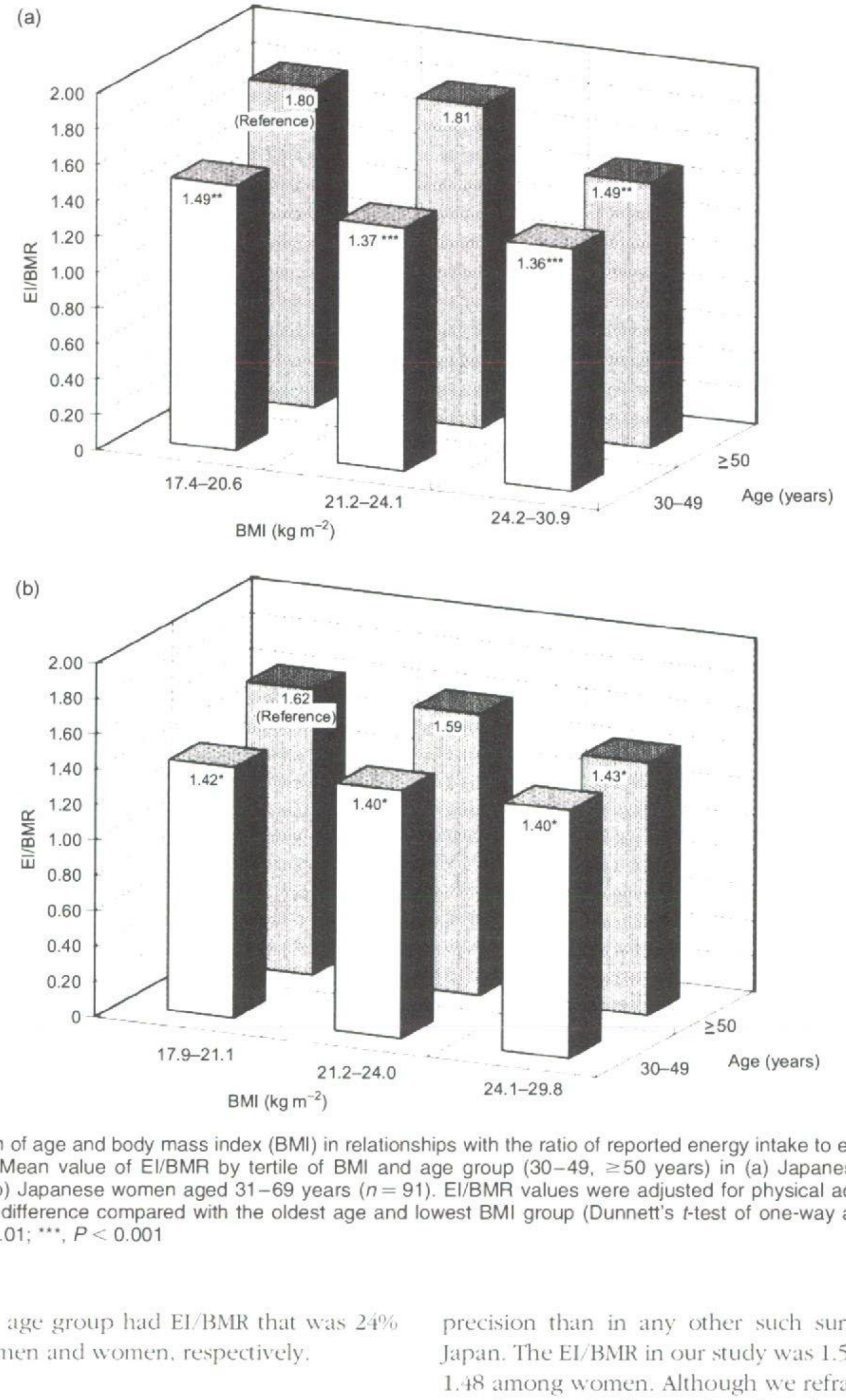

Fig. 1 The interaction of age and body mass index (BMI) in relationships with the ratio of reported energy intake to estimated basal metabolic rate (EI/BMR). Mean value of EI/BMR by tertile of BMI and age group (30–49, ≥50 years) in (a) Japanese men aged 32–76 years ($n = 92$) and (b) Japanese women aged 31–69 years ($n = 91$). EI/BMR values were adjusted for physical activity level and living area. Significance of difference compared with the oldest age and lowest BMI group (Dunnett's t-test of one-way analysis of variance): *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$

BMI and youngest age group had EI/BMR that was 24% and 14% lower in men and women, respectively.

Discussion

To our knowledge, this is the first report to evaluate EI/BMR values over a wide age range of Japanese men and women. We conducted semi-weighed diet records for 4 days in four seasons, which is often considered to be the most accurate and precise method for determining energy intake. Furthermore, fax delivery was used so that we could check the diet records immediately on each survey day. Therefore, we believe that the data have higher precision than in any other such survey conducted in Japan. The EI/BMR in our study was 1.55 among men and 1.48 among women. Although we refrained from using a specific cut-off value to identify underreporters, 20% and 23% of men and women, respectively, showed EI/BMR below 1.27, the minimum survival level reported by FAO/WHO/UNU[19]. Moreover, the proportion of subjects with EI/BMR < 1.27 decreased with increasing age in both sexes, except in the 40–49 year age group in women. However, 10% and 4% of men and women, respectively, showed EI/BMR exceeding 2.0 as the maximum level. Even when physical activity level was considered, the proportion of subjects with EI/BMR > 2.0 increased with increasing age, and was especially more pronounced in the age group ≥60 years for both sexes. This indicates that older Japanese men and women tend to relatively overestimate energy intake rather than underreport.

The main finding of this study was that age and BMI independently affect EI/BMR as a positive and a negative factor, respectively. The statistical power of these findings became stronger after adjustment for potentially confounding factors such as physical activity level and living area (urban or rural) for both sexes (Figs 1a and 1b). According to previous studies, physiological and psychological factors are also related to reporting accuracy; for example, smoking habits, education level, socio-economic status and obesity-related behaviours[14,15,20–22]. However, we did not examine the effect of these factors on reporting accuracy because of a lack of information.

Most studies conducted in Western countries revealed that underreporting of energy intake was more prevalent among older subjects than among younger counterparts[7,23,24]. The tendency was completely opposite in this Japanese population. To our knowledge, no previous study has found underreporting to be more prevalent among younger compared with older subjects, either in Western or Asian countries. Possible factors affecting reporting accuracy may include dietary consciousness and knowledge of foods and diet. According to the National Nutrition Survey in Japan[25], the percentage of subjects who paid high attention to diet and nutrition was 12.1%, 17.5%, 24.4% and 27.2% among 30–39-, 40–49-, 50–59- and ≥60-year-old men, respectively, and 27.5%, 35.7% 42.9%, and 48.6%, respectively, among women. The capability to recognise foods and diet may be related to recording as correctly as possible. Some previous studies reported that cultural, behavioural and psychological factors affect reporting accuracy[14,15,20–22]. The results were, however, inconsistent and differed among the populations examined. Further research focusing on dietary consciousness and behaviours connected with food and the process of dietary assessment is needed.

Our study has several limitations. First, the subjects may not be representative because they were not randomly sampled from the general Japanese population. Moreover, the participants might be highly health-conscious because almost all of them completed the study despite the strict study design. Second, the sample size was relatively small. Therefore, the results may arise by chance. Third, we cannot exclude the possibility that the subjects changed their dietary behaviour or food choices during the recording periods. However, the relationships between EI/BMR and age and body weight did not change materially when the dietary record data of the first four days were used in the analysis (data not shown). Fourth, we used body height to take into consideration body size although body height is not an ideal marker of body size. Fifth, the reliability of the BMR prediction from the FAO/WHO/UNU formulas may be inappropriate when applied to the Japanese population[26]. The validity of the self-reported physical activity levels from the 6th Japanese recommended dietary allowance is questionable because of the lack of a validation study[18].

In summary, the results of the present study suggest that age and BMI may influence the relative accuracy of reported energy intake among Japanese adults. The positive correlation found between age and EI/BMR was especially interesting because almost all previous studies conducted in Western populations showed a negative correlation. This indicates that the factors related to reporting accuracy of energy intake may depend on population characteristics. Further studies are needed to examine whether or not this is a consistent tendency in Asian or Japanese populations.

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Food Intake and Functional Constipation: A Cross-Sectional Study of 3,835 Japanese Women Aged 18–20 Years

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Summary Although we previously observed significant associations between intakes of several foods and constipation, definition of constipation was completely based on subjective perception assessed by a quite simple and single question: do you often have constipation? In this study, we examined the associations between food intake and functional constipation as defined according to symptom-based criteria (Rome I criteria: straining, hard stools, incomplete evacuation, and infrequency of bowel movement). Subjects were 3,835 female Japanese dietetic students aged 18–20 y from 53 institutions in Japan. Dietary intake was estimated with a validated, self-administered diet history questionnaire. The prevalence of functional constipation was 26.2%. Dietary intakes of several foods were significantly associated with functional constipation. A multivariate adjusted odds ratio (95% confidence interval; p for trend) for women in the highest quintile of dietary intake compared with those in the lowest was 0.59 (0.46–0.75; <0.0001) for rice, 0.77 (0.61–0.97; 0.003) for pulses, 1.64 (1.30–2.08; <0.0001) for confectioneries, and 1.41 (1.11–1.78; 0.01) for bread. In conclusion, intake of rice and pulse was negatively and that of confectioneries and bread was positively associated with functional constipation among a population of young Japanese women, which was generally consistent with our previous study where constipation was assessed by a quite simple question.

Key Words dietary fiber, food, rice, functional constipation, epidemiology

Constipation is a common health problem (*1–4*), and food intake is considered to be a major modifiable lifestyle factors associated with this condition (*5, 6*). Foods related to constipation in previous observational studies include dairy products (*7*), beans (*7*), meats (*7*), fruits (*7*), vegetables (*7*), rice (*3, 8, 9*), eggs (*9*), confectioneries (*8*), and several nonalcoholic beverages (*3, 7, 8, 10, 11*). However, while most previous studies have defined constipation according to the infrequency of bowel movement only (*10–13*) or the subjective perception of patients (*7, 8*), a consensus definition of constipation consists of straining, hard stools, and incomplete evacuation in addition to infrequency (Rome criteria) (*14*). Further, although Wong et al. (*3*) and Nakaji et al. (*9*) defined constipation using the Rome criteria and original subjective criteria, respectively, they assessed diet with a non-validated, relatively simple food frequency questionnaire. Moreover, although we previously observed associations between intakes of several foods and constipation (*11*), using a previously validated, self-administered, diet history questionnaire (DHQ) (*15–17*), the definition of constipation was completely based on subjective perception assessed by a quite simple and single question: do you often have constipation? Thus, to our knowledge, no study has so far investigated the relationship of food intake, as assessed with a validated assessment method, to functional constipation, as defined using symptom-based criteria. Here, we examined the associations between food intake, estimated using DHQ, and functional constipation as defined according to the Rome criteria (*14*).

SUBJECTS AND METHODS

Subjects and survey procedure. The present study was based on a self-administered questionnaire survey among dietetic students (n=4,679) from 54 institutions in Japan. Staff at each institution distributed a dietary assessment questionnaire (i.e., DHQ) and another questionnaire on other lifestyle items during the preceding month to students during an orientation session or a first lecture designed for freshman students entering dietetic courses in April 2005; in most institutions, this was carried out within 2 wk after the course began to minimize the influence of new school year life on the answers. Students filled out the questionnaires during the session, lecture, or at home and then submitted the completed forms to staff at each institution. Questionnaires used in the present study included the explanation on how to answer questions. To standardize the survey procedure, when students asked how to answer questionnaires, staff at each institution did not

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provide any advice and only asked students to read the explanation on questionnaires carefully. In addition to the two questionnaires for the preceding month, a third questionnaire on lifestyle during the previous 6 y (i.e., junior high school and high school) was also distributed and answered in a similar fashion; in most institutions, this was carried out within 4 wk after the course began because it was considered burdensome for subjects to answer all three questionnaires at the same time and it was considered unlikely that new school year life would influence the answers for lifestyle during the previous 6 y.

The staff at each institution checked the responses according to the survey protocol. When missing answers or logical errors were identified, the student was asked to complete the questionnaire again. The staff at each institution mailed the questionnaires to the survey center. Staff at the survey center checked the answers again, and when necessary returned problematic questionnaires to staff at the respective institution, and the student was asked to complete the questionnaires again. All questionnaires were thus checked at least once by staff at each institution and by staff at the survey center. Most surveys were completed by May 2005. The protocol of the present study was approved by the Ethics Committee of the National Institute of Health and Nutrition.

In total, 4,286 students (4,066 women and 220 men) answered all three questionnaires (91.6%). For the current analysis, we selected female subjects aged 18–20 y (n=3,967) because of the small number of male subjects and women aged >20 y. We then excluded women who were in an institution where the survey had been conducted at the end of May (n=97) because the answers were likely influenced by the new school year life. We further excluded those with extremely low or high energy intake (<500 kcal/d or >4,000 kcal/d) (n=23) because their estimated dietary intake was likely unreliable. We finally excluded those with missing information on the variables used (n=24) for the purpose of multivariate analyses. As some subjects were in more than one exclusion category, the final analysis sample comprised 3,825 women. Although intentional dietary change or use of oral laxatives might have influence on dietary intake or constipation, further exclusion of subjects with intentional dietary change within the preceding year (n=649), those habitually using oral laxatives (n=231), or both did not materially alter the findings, and these subjects were therefore included in the analyses.

Dietary intake. Dietary habits during the previous month were assessed using a previously validated, self-administered DHQ (*15–17*). This is a 16-page structured questionnaire that consists of the following seven sections: general dietary behavior; major cooking methods; consumption frequency and amount of six alcoholic beverages; consumption frequency and semi-quantitative portion size of 121 selected food and nonalcoholic beverage items; dietary supplements; consumption frequency and semi-quantitative portion size of 19 staple foods (rice, bread, and noodles) and miso (fermented soybean paste) soup; and open-ended items for foods consumed regularly (≥once/wk) but not appearing in the DHQ. The food and beverage items and portion sizes in the DHQ were derived primarily from data in the National Nutrition Survey of Japan (*18*) and several recipe books for Japanese dishes (*15*).

Estimates of dietary intake for 147 food and beverage items and energy were calculated using an ad hoc computer algorithm for the DHQ, which was based on the Standard Tables of Food Composition in Japan (*19*). Information on dietary supplements and data from the open-ended questionnaire items were not used in the calculation of dietary intake. The food and nonalcoholic beverage items were grouped into the 18 food groups (as shown in Table 2). Detailed descriptions of the methods used for calculating dietary intake and the validity of the DHQ have been published elsewhere (*15–17*). The Pearson correlation coefficient (*20*) between DHQ and 3-d estimated dietary records was 0.48 for energy among 47 women (*15*). In addition, the mean value of the Spearman correlation coefficients (*20*) for energy-adjusted intakes (g/1,000 kcal) of 16 food groups was 0.35 (range: 0.05–0.59) among 92 women (Sasaki S, unpublished observations, 2004).

Constipation. A constipation questionnaire was developed based on a previous study (*2*) and incorporated into the 20-page questionnaire for lifestyle during the previous 6 y. We used the definition of functional constipation recommended by an international workshop on the management of constipation (Rome I criteria) (*14*). Although the Rome I criteria were modified in 1999 (Rome II criteria) (*21*), epidemiologic studies have consistently shown that the latter may be too restrictive for the diagnosis of constipation (*2, 4*); we therefore used the former. The Rome I criteria are a consensus definition of constipation consisting of various symptoms including bowel movement frequency (as shown below) (*14*), and have become the research standard for the definition of constipation (*1*). The following four questions were used to assess Rome I-defined functional constipation: 1) Do you strain during a bowel movement?; 2) Do you feel an incomplete emptying sensation after a bowel movement?; 3) How often are your stools hard?; and 4) How many bowel movements do you usually have each week? These questions referred to the last 12 mo. For questions 1–3, four answers were offered: never, sometimes (<25% of the time), often (≥25% of the time), and always. Functional constipation was defined as meeting two or more of the four criteria [an answer of *often* or *always* to questions 1–3 and <3 bowel movements per week (question 4)].

Confounding factors. In epidemiologic research, it is usual to divide the main dependent variables (food intake in the present study) and confounding factors (other lifestyle factors described below in the present study) based on previous studies (*1–13*). Thus, we assessed not only dietary intake but also several lifestyle factors described below in the present survey. In the questionnaires, subjects reported body weight and