Figure 1 Relationship between nutrition and occlusion (χ^2-test, $P < 0.05$). Group A: natural dentition with adequate function. Group B: partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws. Group C: functionally inadequate occlusion with no dentures.
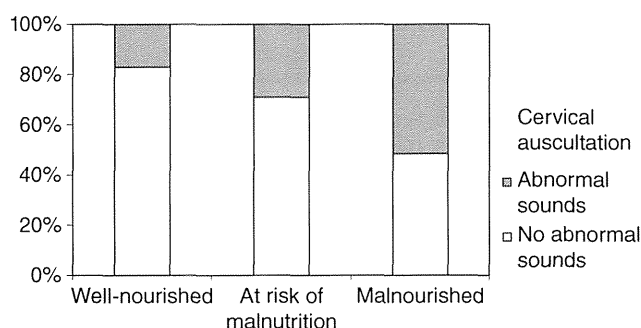

Figure 2 Relationship between nutrition and abnormal swallowing sounds detected by cervical auscultation (χ^2-test, $P < 0.05$).

A significant relationship was also observed between malnutrition and Barthel index, abnormal swallowing sounds by cervical auscultation, and living alone (Table 3).

Discussion

The results of the present study showed that the number of frail elderly with malnutrition was 13.3% (95), which is nearly in agreement with the results of a previous study carried out in Japan.[11] Furthermore, the number of the participants at risk of malnutrition, including those in the at risk of malnutrition and malnourished groups was 64.9% (465), which surprisingly exceeded 50% of the participants. This result shows that improvement in the nutrition status of frail elderly living in home care needs to be urgently addressed.

The Barthel index was the significant factor documenting both malnutrition risk and malnourishment in the present study. Many researchers agree that there is a

relationship between physical function and nutrition status.[12] It might be concluded that individuals whose daily activity is limited tend to avoid shopping for food items, resulting in nutritional disturbance.

In addition to the Barthel index, sex was found to be a significant factor influencing malnutrition risk. The present study showed that older females had a 1.845-fold greater malnutrition risk than older males (95% CI 1.121–3.036), which agreed with the results of a previous study that showed that older females were more likely to develop nutritional disturbance, both obesity and malnutrition.[13]

Furthermore, occlusal status was significantly related to malnutrition risk. The group C individuals (functionally inadequate occlusion with no dentures) had a 3.189-fold greater malnutrition risk than group A (natural dentition with adequate function; 95% CI 1.437–7.080). Chewing efficiency, for example, the rate of breakdown of food during mastication, is clearly correlated with features of the dentition, such as number of posterior teeth and occlusal relationships.[14] The most pronounced difference in intake involves hard-to-chew foods, such as vegetables and some fruits, therefore tooth loss affects elements of nutritional intake, such as dietary fiber and vitamins.[15] These micronutrients are the key element in maintaining good nutrition, which suggests that lack of such food might result in greater malnutrition risk.

In addition, group B (partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws) had a 1.704-fold greater malnutrition risk than group A (95% CI 1.013–2.864). Previous studies have shown that individuals who have lost natural molar contacts consume lesser amounts of hard-to-chew foods, such as vegetables and fruits, even though they use their dentures during food intake.[16] Our findings in the present study support the view that denture use is not sufficient to compensate for natural teeth. Recently, Bradbury *et al.* showed that food instruction encourages an increase in the consumption of vitamins and minerals among new denture wearers.[17] In general, denture treatment has not usually included in such dietary intervention. Future studies will be required to identify the effect of dietary intervention on the prevention of malnutrition in denture users.

In contrast, there was no significant relationship between malnourishment and occlusion in frail elderly participants. There were significant relationships between malnutrition and Barthel index, abnormal swallowing sounds detected by cervical auscultation, and living alone. These results suggest that malnourished elderly have already developed dysphagia resulting in dietary modification;[18] therefore, their malnutrition might be less influenced by a proper occlusal relationship. A vicious cycle, in which decreased ability to

Table 2 Items significantly involved in malnutrition risk

	B	Standard deviation	Wald	P-value	Exp (B)	95% Confidence interval	
Sex	0.612	0.254	5.803	0.016	1.845	1.121	3.036
Age	−0.001	0.015	0.006	0.939	0.999	0.971	1.028
Charlson index	0.089	0.082	1.168	0.280	1.093	0.930	1.284
Barthel index	−0.036	0.005	43.381	0.000	0.965	0.955	0.975
Clinical Dementia Rating	0.156	0.140	1.251	0.263	1.169	0.889	1.537
Swallowing sounds	0.482	0.297	2.627	0.105	1.619	0.904	2.900
Occlusal relationship (a) group A vs group B	0.533	0.265	4.039	0.044	1.704	1.013	2.864
Occlusal relationship (b) group A vs group C	1.160	0.407	8.125	0.004	3.189	1.437	7.080
Living alone	0.353	0.301	1.380	0.240	1.424	0.790	2.567
Constant	1.701	1.265	1.807	0.179	5.479		

The participants were divided into two groups according to their nutrition status: (i) a well-nourished group; and (ii) a group that included those at risk of malnutrition and malnourished. Group A, natural dentition with adequate function; group B, partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws; group C, functionally inadequate occlusion with no dentures.

Table 3 Items significantly involved in malnutrition

	B	Standard deviation	Wald	P-value	Exp (B)	95% Confidence interval	
Sex	0.613	0.388	2.501	0.114	1.846	0.864	3.947
Age	−0.002	0.021	0.007	0.933	0.998	0.958	1.040
Charlson Index	0.014	0.104	0.019	0.891	1.014	0.827	1.244
Barthel Index	−0.035	0.007	27.940	0.000	0.966	0.953	0.978
Clinical Dementia Rating	−0.072	0.178	0.165	0.685	0.930	0.657	1.318
Swallowing sounds	1.060	0.340	9.684	0.002	2.885	1.480	5.623
Occlusal relationship (a) group A vs group B	−0.453	0.391	1.343	0.246	0.636	0.295	1.368
Occlusal relationship (b) group A vs group C	−0.485	0.520	0.871	0.351	0.616	0.222	1.705
Living alone	1.461	0.403	13.143	0.000	4.312	1.957	9.502
Constant	−0.746	1.777	0.176	0.674	0.474		

Participants were divided into two groups according to their nutritious status: (i) a group of well-nourished individuals and those at risk of malnutrition; and (ii) a group of malnourished individuals. Group A, natural dentition with adequate function; group B, partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws; group C, functionally inadequate occlusion with no dentures.

swallow food could accelerate malnutrition, was also considered. Elderly people who live alone are less likely to follow through with dietary modification,[19] and it might lead to malnutrition regardless of occlusal status.

In conclusion, the present study, as well as previous studies, has shown that retaining the natural teeth plays an important role in the prevention of nutritional disturbance, and that early dental treatment in the elderly is important to protect their teeth and occlusion. Dieticians, as well as other care staff, should monitor oral conditions, such as remaining teeth and occlusion, in the elderly in order to prevent malnutrition. We also suggest that all dentists enhance their skills and knowledge in the fields of swallowing function and nutritional guidance.

Acknowledgments

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原　著

成人知的障害者の身体計測と身体組成からみた栄養評価

田村文誉[1,2]・戸原　雄[1,2]・西脇恵子[1,2]・白潟友子[2]
元開早絵[1,3]・佐々木力丸[1,2]・菊谷　武[1,3]

要旨：本研究は，成人知的障害者の栄養状態の評価として身体計測および身体組成測定器を用いることの有用性を示し，さらに成人知的障害者の栄養状態の実態を明らかにすることを目的として行った．

調査参加者は，関東近県にある某知的障害者自立支援施設入居の知的障害者で，本研究に家族の同意が得られた25名中，栄養評価が可能であった23名；平均年齢42.7±12.1歳（男性12名；平均年齢35.5±7.7歳，女性11名；平均年齢50.5±11.1歳）をMR群，ボランティアの健康成人46名；平均年齢40.3±11.4歳（男性27名；平均年齢36.5±9.8歳，女性19名；平均年齢45.8±11.5歳）をHE群とした．MR群ならびにHE群に対して，身長および体重，簡易型皮下脂肪厚測定器（アディポメーター®，アボットジャパン）とメジャーテープ（インサーテープ®，アボットジャパン）を用い上腕を計測し，身体計測法から得られた結果（体格指数；BMI，上腕周囲長；AC，上腕三頭筋皮下脂肪厚；TSF，上腕筋面積；AMA，上腕筋囲；AMC）について，日本人の新身体計測基準値JARD 2001の各年齢群，性別の中央値と比較した．また，簡易型生体電気インピーダンス分析器（Bodystat®，Bodystat Ltd.）を用いて体脂肪量，除脂肪量を測定した．

統計学的検討には，Student's t 検定またはWilcoxon検定を用いた．また独立性の検定には，Fisherの直接確率計算法を用いた．

MR群の男性では，JARD 2001の中央値と比較してすべての身体計測値で有意に低値を示し，HE群と比較して体水分％が有意に多い結果であった（p＜0.01）．女性では，AMCとAMAにおいてJARD 2001の中央値と比較して有意に高値であり（p＜0.05），体脂肪％がHE群と比較して有意に低値であった（p＜0.05）．

MR群男性において栄養状態は不良であり，改善が必要であることが示唆された．知的障害者の栄養状態を検討する際には身長，体重などの身体計測のみならず，体水分量，体脂肪率などの身体組成を測定することが重要であると考えられた．

Key words：Intellectual disabilities, Nutritional assessment, Anthropometric, Body composition

緒　言

知的障害者では，乳幼児期に摂食機能の遅れがあるにもかかわらず，療育者がそれに気づかず，健常児と同じペースで哺乳から離乳へと進められることで，摂食機能発達の遅延や押し込み食べや早食いなどの異常な摂食パターンを獲得する場合がある[1]．大和田ら[2]による障害児（者）の健康・栄養状態に関する実態調査においても，早食い，過食，偏食，異食が多いと報告されている．そのため，栄養摂取のコントロールが困難になり，栄養摂取過多による肥満が問題になる[3,4]一方，栄養摂取不足によるやせという問題[5]もみられる．佐藤ら[6]は，知的障害をもつ者のうち，粗大運動能力が高い児は，体重や体脂肪が高い傾向にあり，粗大運動能力が未熟な者は体重や体脂肪が低い傾向にあると報告している．その一方，田村ら[7,8]は知的障害者においては必要エネルギー量が充足されているにもかかわらず，やせの状態を呈する者が多くみられることを報告した．

個人の栄養状態の指標として体脂肪率の測定をする場合があるが，その方法としては，水中体重秤量法，CTスキャンなどが用いられる．知的障害者の特性を考えると，短時間かつ非侵襲的な方法を用いることが望ましく，これらの方法は困難であるためほとんど行われていない．生体電気法は短時間で非侵襲的に体脂肪を測定でき，かつ，妥当性および客観性や信頼性に優れていると報告されている[3,9~11]．そこで今回，身体組成測定器Bodystat®を用いて，成人知的障害者の身体組成から栄養状態の実態を明らかにすることを目的として研究を行った．

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対象ならびに方法

調査参加者については，関東近県にある某知的障害者自立支援施設入居の知的障害者で，本研究に家族の同意が得られた 25 名中，栄養評価が可能であった 23 名；平均年齢 42.7±12.1 歳（男性 12 名；平均年齢 35.5±7.7 歳，女性 11 名；平均年齢 50.5±11.1 歳）を MR 群，ボランティアの健康成人（歯科医療関係者）46 名；平均年齢 40.3±11.4 歳（男性 27 名；平均年齢 36.5±9.8 歳，女性 19 名；平均年齢 45.8±11.5 歳）を HE 群とした．なお，MR 群と HE 群の全体間，男性間，女性間それぞれの年齢に統計学的有意差は認められない（全体；p＝0.428，男性；p＝0.740，女性；p＝0.279）．

個人の健康調査票より，MR 群の知的障害は中程度から重度であり，てんかんの既往歴のある者は 3 名であった．その他特記すべき疾患を有する者はみられなかった．MR 群の咬合状態は，アイヒナー分類[12]にて，ランク A が 12 名，ランク B が 10 名，ランク C が 1 名であった．一方，HE 群の口腔内は，全員が特記すべき解剖学的異常のない個性正常咬合であった．

MR 群および HE 群に対して，栄養評価として，身体計測と身体組成を用いた．身体計測では，身長および体重を測定し，BMI を求めた．また，身体計測法から得られた結果（体格指数；BMI，上腕周囲長；AC，上腕三頭筋皮下脂肪厚；TSF，上腕筋面積；AMA，上腕筋囲；AMC）について，年齢に応じた値としての比較をするために，日本人の新身体計測基準値 JARD 2001[13]の各年齢群，性別の中央値と比較した．

次に，簡易型生体電気インピーダンス分析器（Bodystat®，Bodystat Ltd.）を用いて身体組成（体脂肪％，除脂肪％，体水分％，推定基礎代謝量；EMR，推定エネルギー所要量）を評価した．身体組成の評価は，被測定者の体の右側の手の甲と足の甲に電極を貼付後，数秒で測定された．身体計測については，簡易型皮下脂肪厚測定器（アディポメーター®，アボットジャパン）とメジャーテープ（インサーテープ®，アボットジャパン）を用い，管理栄養士が評価を行った．身体組成の結果については，JARD 2001 のような年齢に応じた基準値がないため，MR 群と HE 群の比較を行った．

さらに MR 群に対し昼食時の食事観察評価を行い，食行動について，知的障害者の摂食時の症状として挙げられている症状[14]のうち，本対象施設入所者で多く認められた，早食い（かき込み），むせ，ため込み，注意散漫（食事時間が長い），問題なし，に分類した．

統計学的検討には，Levene 検定にて等分散を示したものには Student's t 検定を，等分散を示さないものについては Wilcoxon 検定を用いた．また独立性の検定には，Fisher の直接確率計算法を用いた．

倫理性の配慮

対象者の保護者に対し，口頭または文書にて本研究の主旨と手順について説明を行い，文書にて同意を得た．なお，本研究は日本歯科大学生命歯学部倫理委員会の承認を得て行われた（承認番号 2110）．

結　　果

1. 身体計測値

身体計測法から得られた結果を，JARD 2001 の基準値と比較した．図 1-1 に MR 群全体，図 1-2 に MR 群男性，図 1-3 に MR 群女性の四分位，図 2-1 に HE 群全体，図 2-2 に HE 群男性，図 2-3 に HE 群女性の四分位を示す．MR 群では，すべての項目において 25 パーセンタイル値未満の者が多く，分布に偏りがみられた．

JARD 2001 の中央値との比較について，MR 群を表 1 に，HE 群を表 2 に示した．MR 群において，全体のデータでは TSF が有意に低値であった（p＜0.01）．また男性ではすべての項目において，有意に低値であった（p＜0.01）．女性では，AMC と AMA において有意に高値であり（p＜0.05），有意に低値のものはみられなかった．HE 群では，全体，男性，女性のいずれも BMI，AC において有意な差は認められなかった．全体および男性では，AMC，AMA において有意に高値であった（全体；p＜0.05，男性；p＜0.01）．一方女性では，TSF で有意に低値であった（p＜0.05）．

2. 身体組成

身体組成値について，MR 群と HE 群の比較を行った（表 3）．

1）除脂肪％対体脂肪％の比

除脂肪％と体脂肪％の比をみると，全体および女性では，MR 群と HE 群との間に有意差が認められた（p＜0.05）．

2）体水分％

体水分％は，男性において，MR 群は HE 群と比較して有意に高値であった（p＜0.01）．

3）推定基礎代謝量（EMR）

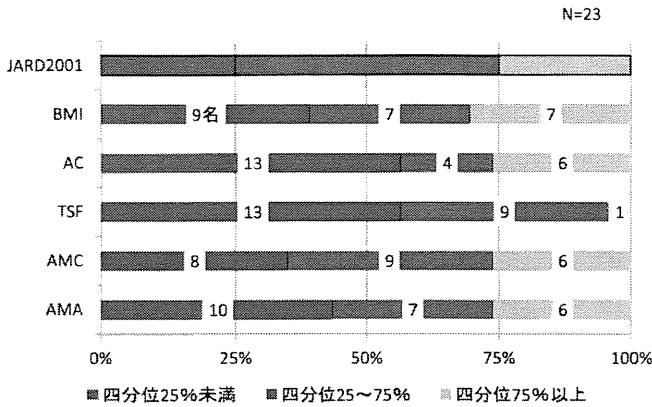推定基礎代謝量（EMR）は，全体および男性では，MR 群は HE 群と比較して，有意に低値であった（p＜0.0001）．
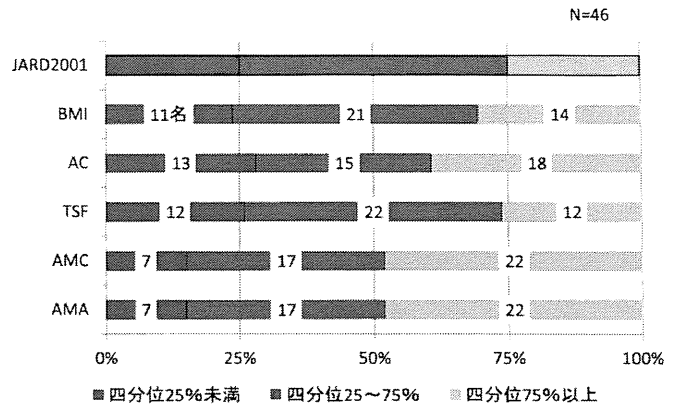
N=23

図1-1　MR群全体の身体計測値とJARD 2001四分位との比較
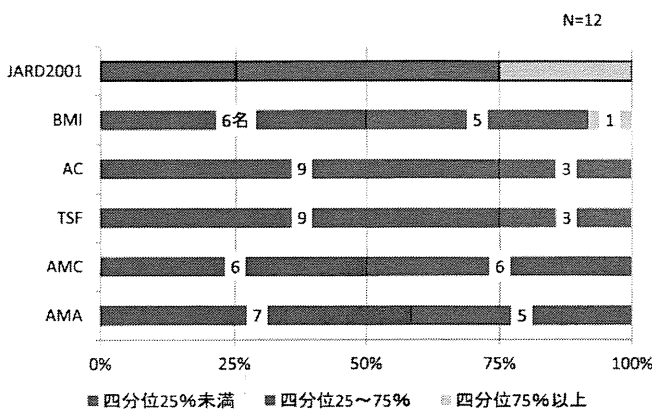
N=46

図2-1　HE群全体の身体計測値とJARD 2001四分位との比較
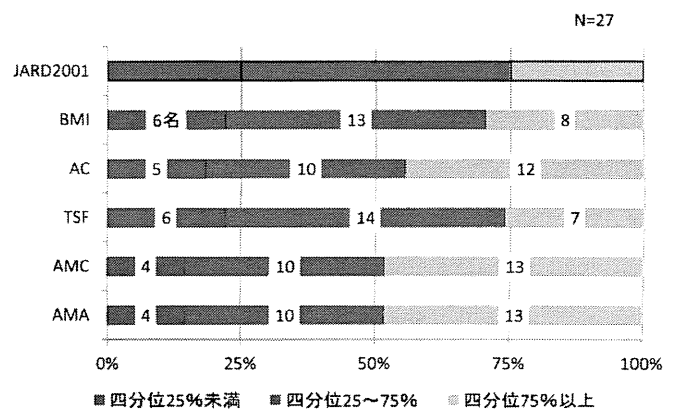
N=12

図1-2　MR群男性の身体計測値とJARD 2001四分位との比較

N=27

図2-2　HE群男性の身体計測値とJARD 2001四分位との比較

N=11
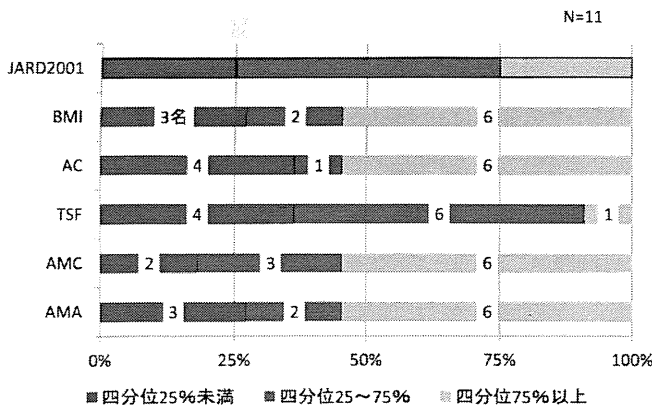

図1-3　MR群女性の身体計測値とJARD 2001四分位との比較

N=19

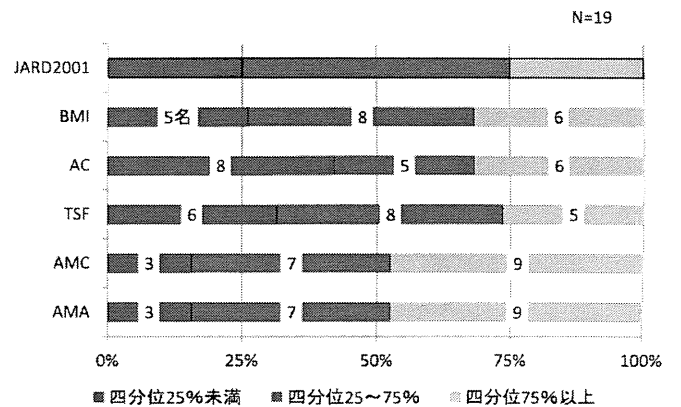
図2-3　HE群女性の身体計測値とJARD 2001四分位との比較

4）推定エネルギー所要量

推定エネルギー所要量は，全体および男性では，MR群はHE群と比較して，有意に低値であった（全体；$p < 0.01$，男性；$p < 0.05$）．

3. 食事時の外部観察評価

MR群の食事時の外部観察評価を行ったところ，早食いが12名，むせが3名，ため込みが3名，注意散漫が1名にみられた．問題なしは4名であった．それらを，BMIの四分位に分けて，全体を図3-1，男性を図3-2，女性を図3-3に示した．BMI 25パーセンタイル値未満，75パーセンタイル値以上では，食行動に問題なしの者はみられなかった．なおHE群では，食事に関する問題のある者はみられなかった．喫食率については，MR群，HE群ともに100％であった．

表1　MR 群の各個人身体計測値と JARD 2001 中央値との比較

	全体（N＝23）		男性（N＝12）		女性（N＝11）	
	Mean±SD	p 値	Mean±SD	p 値	Mean±SD	p 値
MR 群の BMI JARD 2001 の BMI	22.1±4.6 22.4±1.0	0.801	20.0±3.1 23.2±0.2	0.002	24.5±5.0 21.5±0.7	0.063
MR 群の AC JARD 2001 の AC （cm）	25.8±3.2 27.1±1.4	0.084	24.8±2.3 28.3±0.5	0.0001	26.4±4.3 25.8±0.7	0.382
MR 群の TSF JARD 2001 の TSF （mm）	10.7±4.7 14.1±2.6	0.004	8.4±2.9 12.3±1.3	0.001	13.3±4.9 16.1±2.1	0.100
MR 群の AMC JARD 2001 の AMC （cm）	22.4±2.4 22.4±2.0	0.983	22.2±1.6 24.3±0.0	0.0001	22.6±3.0 20.4±0.3	0.026
MR 群の AMA JARD 2001 の AMA （cm²）	40.4±8.5 40.3±7.0	0.979	39.4±5.9 46.8±1.0	0.0001	41.2±11.1 33.2±1.1	0.026

表2　HE 群の各個人身体計測値と JARD 2001 中央値との比較

	HE 群全体（N＝46）		HE 群男性（N＝27）		HE 群女性（N＝19）	
	Mean±SD	p 値	Mean±SD	p 値	Mean±SD	p 値
HE 群の BMI JARD 2001 の BMI	22.9±3.4 22.5±0.8	0.432	23.8±3.0 23.0±0.5	0.192	21.6±3.6 21.6±0.6	0.979
HE 群の AC JARD 2001 の AC （cm）	27.7±3.7 27.2±1.1	0.341	29.0±3.2 27.9±0.5	0.081	25.9±3.7 26.0±0.7	0.892
HE 群の TSF JARD 2001 の TSF （mm）	12.2±4.2 13.1±2.9	0.216	11.0±3.6 11.2±1.2	0.851	13.7±4.6 16.3±1.7	0.035
HE 群の AMC JARD 2001 の AMC （cm）	23.9±3.4 22.7±1.8	0.037	25.6±2.6 24.1±0.3	0.007	21.6±3.1 20.4±0.2	0.109
HE 群の AMA JARD 2001 の AMA （cm²）	46.5±13.3 41.2±6.4	0.021	52.5±11.0 46.1±1.1	0.006	37.9±11.5 33.2±0.7	0.096

考　　察

　本研究では，施設に入所する成人知的障害者の栄養状態を評価するために，身体計測値の検討には JARD 2001[13]を用いた．これは，MR 群と HE 群の平均年齢に差がないようマッチングしたものの，年齢階級が全くの同一ではないため単純に群間比較すべきではなく，年齢にふさわしい値をもっているかどうか，それぞれの群で調べる必要があると考えたためである．一方，インピーダンスによる身体組成は JARD 2001 のような基準値がないため，体格を客観的に表す BMI を指標とし，この BMI が標準範囲内である HE 群との比較を用いた．インピーダンス法は，人体を構成する水分，脂質，たんぱく質などの身体組成を測定することができる．再現性の高さや BMI との相関の高さから，インピーダンス法は比較的信頼度が高い測定方法であるとされている[3,9~11]．知的障害者の身体計測を行う際，指示に従え

表3　インピーダンス法による身体組成値における MR 群と HE 群との比較

		全体		男性		女性	
		比	p 値	比	p 値	比	p 値
除脂肪% 対 体脂肪% 比	MR 群	71.5：28.5	0.025	78.6：21.4	0.070	63.7：36.3	0.024
	HE 群	78.0：22.0		82.5：17.5		71.6：28.4	

		全体		男性		女性	
		Mean±SD	p 値	Mean±SD	p 値	Mean±SD	p 値
体水分%	MR 群	60.5±10.2	0.704	66.3±7.8	0.008	54.1±8.8	0.145
	HE 群	59.6±5.9		60.4±5.1		58.4±6.8	
推定基礎 代謝量 (EMR)	MR 群	1,289.2±256.2	0.0001	1,360.4±303.1	0.0001	1,211.5±175.0	0.194
	HE 群	1,555.2±279.7		1,746.8±182.3		1,283.0±119.7	
推定エネル ギー所要量	MR 群	2,024.8±465.0	0.007	2,169.5±522.5	0.014	1,867.0±350.5	0.621
	HE 群	2,333.0±419.7		2,620.4±273.5		1,924.5±179.5	

ず，身長，体重や，TSF，AC などの身体計測を行うことが困難である者も多くみられた．通常のインピーダンス法は立位を必要とするが，身体組成測定 Bodystat[®] の電極を用いたインピーダンス法は，短時間かつ仰臥位の測定が可能であり，簡便・無侵襲で身体組成測定を行える特徴がある．本研究でもすべての対象者で計測が可能であり，知的障害者の詳細な栄養状態を把握するうえでは有用であると考えられた．なお，栄養評価で用いる血清アルブミン値（Alb）は栄養状態を表す重要な項目であるが，本研究の対象である MR 群においては採血時の拒否によりデータとして十分に採取できず，検討に加えることができなかった．

　本研究の結果では，身体組成を指標とする栄養状態において，MR 群の男性では，JARD 2001 の中央値と比較してすべての身体計測値で有意に低値を示し，HE 群と比較して体水分%が有意に多い結果であった．人体は，骨格筋，骨，血液，皮膚および内臓などの除脂肪組織と脂肪組織から構成されており，除脂肪組織は実質的生体機能の本体を示し，全身の代謝活性や生物学的機能の主要な部分と関連している[15]．一方，体脂肪はたんぱく質の節約作用や体温の維持に関与する[15]．体水分%が多いということは体脂肪が少ないことを意味するため，MR 群男性では，エネルギーの貯蔵や生命維持に必要なたんぱく質の成分が少ない可能性を示唆している．MR 群男性では BMI でやせを示す者が多く，さらに体脂肪が少ない傾向にあることから，栄養状態は BMI で示されるよりもさらに不良であると推測された．一方 MR 群女性では JARD 2001 の中央値に比較して BMI は標準範囲内であることから，MR 群では男性より女性のほ

うが栄養状態は良好に見受けられる．しかしながら，MR 群女性は AMC および AMA が有意に高値であったことから，栄養状態が良好というよりもむしろ肥満傾向にあると考えられた．一般女性においても，年齢を重ねるとともに肥満の頻度が増加し，30 代までは 7 人に 1 人の割合だったものが，40・50 歳代では 5 人に 1 人，60 歳以上では 4 人に 1 人へ増加する[16]．中高年の女性は内臓脂肪型肥満の頻度が高いが，閉経後にエストロゲンが減少することが，内臓脂肪の急速な増加と関連しているとされる[17]．MR 群女性の平均年齢は 50 歳であり，健康成人女性と同様に内臓脂肪の急速な増加時期を迎えたことによる肥満傾向を呈したものと推測される．

　知的障害者の体格については，肥満の頻度が高いと報告[2,18~21]されているが，単なる生活習慣病での肥満とは異なるメカニズムが関与している可能性[22]も示唆されている．特に，早食いや過食，詰め込みなどの食行動の異常[23]がある場合，食事摂取量が過多となる可能性は大きいと考えられる．ただし，本研究において，対象施設で提供される食事量は規定されていることから，過剰なエネルギー摂取が原因ではなく，制限された生活範囲内での活動量の減少が，MR 群女性の肥満傾向の要因と推測された．しかし一方では，やせにも配慮が必要である[2,23]．長瀬ら[4]，大下ら[24]は，男性において，やせとなる割合が高いこと，また女性では，肥満になる割合が高いことを報告しており，本研究の結果もそれを裏付けるものであった．本研究での食行動と BMI との関連の結果から，食行動の問題がない者は BMI 四分位の 25～75%の標準範囲内に位置し，一方，食行動の異常がみられる者では，男性ではやせに，女性では肥満になる可能
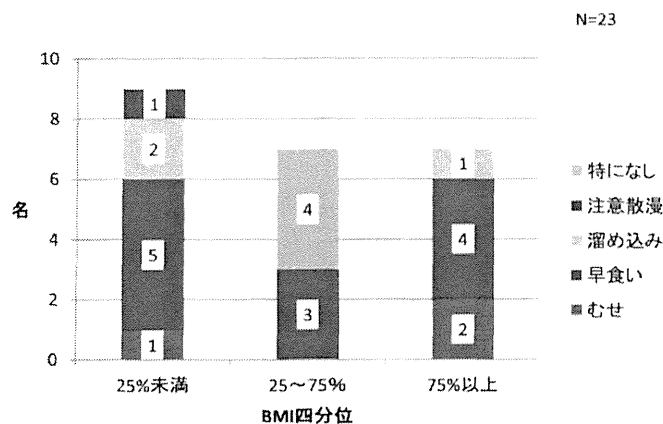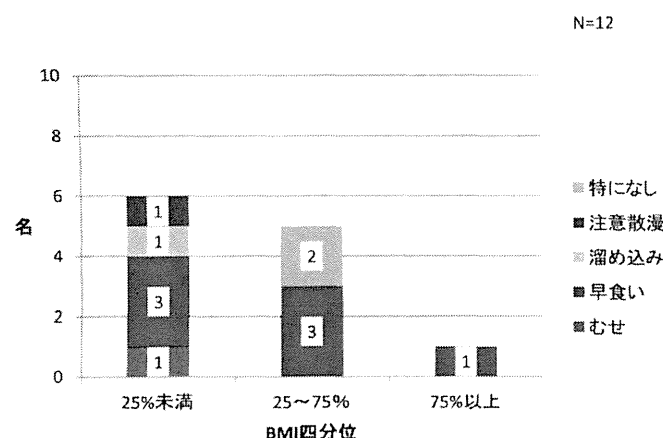
N=23

図3-1　MR 群全体の BMI 四分位と食行動との関係

N=12

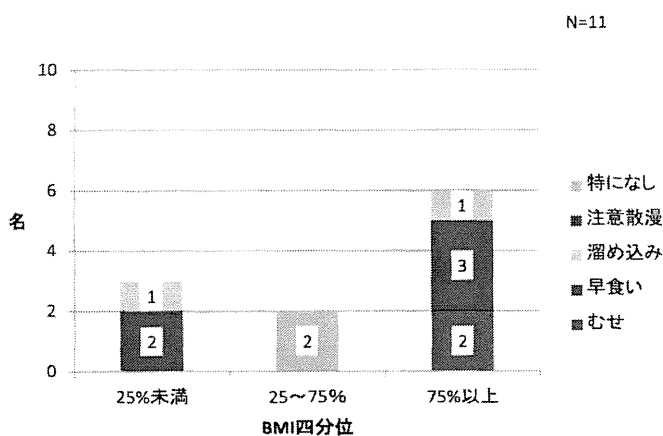図3-2　MR 群男性の BMI 四分位と食行動との関係

N=11

図3-3　MR 群女性の BMI 四分位と食行動との関係

性が大きいことが窺われた．やせの者のなかには，感覚異常により拒食や偏食を呈する[24～27]ため，食事摂取量が極端に少ないことが原因の可能性もあるが，また消費エネルギーの大きさ[27]が原因となりうることも推察される．MR 群男性は推定基礎代謝量，推定エネルギー所要量ともに HE 群より有意に少なかったが，これは日常生活活動から推定された身体活動量が少なかったためと推察される．しかし大和田ら[28]は，知的障害者は日常生

活活動量が不十分であるため，有酸素運動や運動機能の低下を招き，実際には余分な体動によりエネルギー消費量を増加させていると述べている．一般に，知的障害者では活動量が少ない印象を受けがちであるが，一方その身体能力の低さからエネルギー消費に負担がかかっている可能性があり，それがやせの一因となりうることも推測された．したがって，知的障害者の栄養状態を評価する際には，健常成人の尺度を採用することは不適当であり，個々の障害の特性を鑑み，総合的に検討することが必要と考えられた．知的障害者の栄養状態を検討する際には身長，体重などの身体計測のみならず，筋たんぱく量，体脂肪率などの身体組成を測定することが重要であると考えられた．身体組成については JARD 2001 のような年齢に応じた標準値がなく，またこれまでに障害のある者についての報告もないことから，今後は年齢や疾患特性に応じた基準値の確立が必要と思われる．

結　　論

本研究の結果より，知的障害者は健康成人と比較して栄養状態が不良であり，特に男性にその傾向が強い可能性があると考えられた．

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利益相反の開示

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Nutritional Assessment by Anthropometric and Body Composition of Adults with Intellectual Disabilities

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Objective : This study aimed to demonstrate the usefulness of a physical measurement and a body-composition measuring electrode for evaluating the nutritional status of adults with intellectual disabilities, and to clarify their actual nutritional status.

Subjects and methods : Of 25 residents of an institution for adults with intellectual disabilities located in one of the prefectures in the Kanto region in Japan whose family members gave written informed consent, 23 (mean age of 42.7 ± 12.1 years) whose nutritional status was able to be evaluated (12 men with a mean age of 35.5 ± 7.7 years, and 11 women with a mean age of 50.5 ± 11.1 years) were enrolled as the MR group. The severity of their intellectual disability was moderate to severe. The control group (HE group) consisted of 46 healthy adults (mean age of 40.3 ± 11.4 years ; 27 men with a mean age of 36.5 ± 9.8 years, and 19 women with a mean age of 45.8 ± 11.5 years). The height and body weight were measured, and the arm circumference was measured using a simple indicator of fat beneath the skin (Adipometer®, Abbot Japan Co., Tokyo) and a measuring tape (Insertape®, Abbot Japan Co., Tokyo). The results of the physical measurement (body mass index [BMI], arm circumference, triceps skinfold thickness, arm muscle area [AMA], and arm muscle circumference [AMC]) were compared with the median of the corresponding age groups and gender using JARD 2001 as a reference. In addition, the body fat and fat-free mass were measured using a simplified analyzer of bio-electricity impedance (Bodystat®, Bodystat Ltd., UK) electrodes. For statistical analysis, after the Levene test was performed, homogeneity data were analyzed by the Student's t test while non-homogeneity data were analyzed using Wilcoxon's test. Fisher's exact probability test was used to examine independence.

Results : The survey revealed that all values of physical measurements were lower in the MR group of men than the median values of JARD 2001 (p<0.01). The water amount % of the MR group was larger than that of the HE group. In the MR group of women, AMC and AMA were greater than those of the median values of JARD 2001 (p<0.05), and body fat was lower than that of the HE group (p<0.05).

Conclusion : These findings suggest that the nutritional status of men in particular with intellectual disabilities is poor and needs to be improved. It is important to clarify the nutritional status of people with intellectual disabilities, including not only physical measurements but also body composition.

A Problem-Based Learning Tutorial for Dental Students Regarding Elderly Residents in a Nursing Home in Japan

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Abstract: This educational trial was an eight-day problem-based learning (PBL) course for fourth-year predoctoral students at Okayama University's dental school who interviewed elderly residents living in a nursing home. The purpose of this PBL course was to introduce geriatric dentistry to the students by allowing them, independently, to discover the clinical problems of elderly patients as well as the solutions. The sixty-five students were divided into nine small groups and received patient information (age, gender, degree of care needed, medical history, food type, medications, and oral condition) in datasheets before visiting the nursing home. Each group of students directly interviewed one patient and the caregivers and identified the patient's medical, psychological, and social problems. After the interview, the students participated in a PBL tutorial to delineate a management approach for the patient's problems. To measure the efficacy of this program, the students completed a questionnaire before and after the course regarding their level of understanding of and attitudes toward geriatric dentistry, clinical research, and self-study. The results showed that students' perceptions of their knowledge about and attitudes toward oral health care for the elderly significantly increased after the PBL course, which suggests that such tutorials should be an option for dental curricula.

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Currently, the worldwide increase in life expectancy has caused a rise in the number of senior citizens,[1] which, in Japan, exceeds 20 percent of the total population.[2] As the number of seniors increases, specialized services have been developed and adopted to improve seniors' quality of life. In dentistry, several dental treatments, including prosthetic rehabilitation, have been largely reported to improve the oral health-related quality of life of elderly patients.[3,4]

It is important that dental students understand the daily life needs of elderly patients as well as approaches for managing them. Such an understanding of their needs should include not only their physical but also their social and psychological functioning. A particular group of individuals, however, who present more dramatic physical or mental impairments (e.g., Alzheimer's disease and cerebrovascular diseases) usually search for higher levels of personal care and support at long-term nursing homes. Additionally, these frail elderly or bedridden patients frequently have some difficulty eating or swallowing due to prosthodontics problems or oropharyngeal dysphagia (e.g., choking, coughing, and aspiration of food or saliva), which eventually may lead to malnutrition and immune system compromise, dehydration, or even aspiration pneumonia. Under these circumstances, predoctoral dental students rarely will have the opportunity to treat such frail elderly or bedridden patients in the usual dental curriculum because of these patients' inability or great difficulty in receiving treatment at dental schools.

Currently, it is becoming more common in Japan for general dentists to visit disabled elderly patients in their own homes or at nursing care facilities in order to deliver dental treatments, which are partially covered by Japanese national insurance. Henceforth, due to the growing demand of such services, there is also a need to increase the numbers of dental schools offering geriatric training courses at nursing care facilities in order to enable early student contact with this patient population and to expand students' future perspectives; at the same time, this would produce better prepared professionals and eventually enable the provision of better health services to communities. According to reports published in 2003 and 2005, there are only a few dental schools providing clinical training courses on geriatric dentistry in health care facilities outside schools in the United States and Europe.[5,6] Similarly, in Japan, only ten out of twenty-nine dental schools have geriatric clinical training programs; among

these, only six include geriatric clinical training at long-term nursing care facilities.[7,8]

In this context, Okayama University's dental school started a problem-based learning (PBL) course in 1996,[9-11] and in 2009 it started a visiting program to elderly nursing care facilities. Our previous study reported that student knowledge about evidence-based medicine (EBM) increased after the tutorial course.[12] In another study focused on dental students who visited elderly patients in nursing homes, Tohara et al. reported that internships in the nursing home helped students understand elderly patients,[13] but those students had already received some clinical experience and did not probe for the patients' problems in that study, i.e., that study did not involve a PBL program.

Although PBL has been widely adopted by many medical and dental schools, its efficacy is still debated. A systematic review of PBL in academic health education reported that, at the level of randomized controlled trials and comparative studies, no clear difference was observed between PBL and conventional teaching. Paradoxically, only comparative studies of single PBL interventions in a curriculum yielded results that were consistently in favor of PBL.[14] Particularly in the dental field, PBL track students have been found to score significantly higher than the traditional track students.[15-19] In another study, PBL improved the educational effect of self-study and clinical inference ability in comparison to lecture-based learning.[20] Although other studies reported that there was no difference in performance between the PBL and the traditional lecture students on examinations,[21,22] a four-year measurement of mock patient examinations and follow-up clinic patient examinations found that using the PBL methodology resulted in student performance of nonsurgical periodontics skills at a level equal to or greater than that of a conventional approach.[22]

In our current PBL course, the students interviewed elderly patients at a nursing care facility with the aim not only of prosthodontic treatment or EBM but also of treating other aspects related to patients' medical conditions or welfare (e.g., dementia, eating, and quality of life). This article reports the results from this course.

Materials and Methods

This PBL course focused on fourth-year dental students at Okayama UIniversity who had no previ-

ous clinical experience. In Japan, dental schools have six-year programs. At Okayama University, dental students start clinical courses during the fourth year. We conducted this tutorial course in the early period of the fourth year; therefore, the students had not taken clinical courses at that time. The sixty-five students were assigned to nine groups of seven to eight members, and the general instructional objectives and specific behavioral objectives of this course were explained to them (Table 1).

The training course lasted eight days (Figure 1). On day 1, all students received a lecture on general geriatric dentistry and received the patient

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Table 1. General instructional objectives and specific behavioral objectives of this PBL course

General instructional objectives
1. To understand the concept of a patient-oriented system (POS).
2. To identify the problems of dependent elderly patients in a nursing home.
3. To provide management approaches.

Specific behavioral objectives
1. To be able to explain the medical treatment concept of a POS.
2. To experience a medical interview with an actual inpatient.
3. To understand patients' complaints and identify their needs.
4. To experience the process of how to manage patients' problems.
5. To make a case report.

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information datasheet (e.g., age, gender, degree of care needed, medical history, activities of daily life, food type, medications, and oral condition), as shown in Figure 2. If necessary, the dental chart was also utilized for additional consultations. On the second or third day, half of the groups interviewed and examined the patients alternately. A total of nine patients (female to male ratio 7:2), with an age range of seventy-five to ninety-two years, agreed to participate (Table 2). According to the classification of level of care (levels 1 to 5) of Japan's Ministry of Health, Labour, and Welfare, all patients needed some degree of care, and seven of them needed care level 3 or above (the elderly patient could not stand up or walk independently and needed toileting assistance). All patients had some history of systemic illness, with cardiovascular or cerebrovascular diseases being the most common. Bone fracture (four out of nine patients) and pneumonia (three out of nine patients) were also prevalent. Seven of the nine patients were receiving food of a normal consistency. The remaining tooth number was variant, and most patients were using removable dentures. Permission to visit the nursing home, conduct the program, and publish the results was obtained from the Okayama University Dental School Committee. On days 4 through 7, the students participated in a PBL tutorial and discussed the patients' problems and methods for managing them within each group. On day 8, each group presented the patient case.

Figure 1. PBL course schedule

DOS: doctor-oriented system, POS: patient-oriented system

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Intra-oral condition

Group B

Patient: 90 years old, female

Degree of care needed: 2 (needs help to stand up in daily activities, early signs of dementia)

Medical history:
Fundal hemorrhage, cholecystectomy, hip osteoarthritis, hypertension, asthma, cardiac arrest

Activities of daily living:
Needs some help in daily activities, riding a wheel chair, can communicate with others, currently no asthma attack, likes origami

Food form: general diet, can eat by herself

Medications:
Azosemide, Eplerenone, Torasemide, Olmesartan, Medoxomil, Amlodipine besilate, Allopurinol, Digoxin, Famotidine, Bezafibrate, Brotizolam
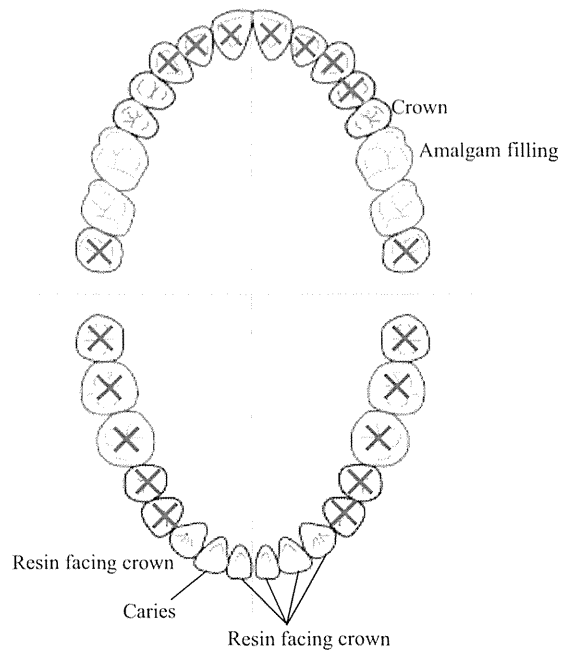

Figure 2. Example of a patient's information datasheet given to students before patient interviews

Note: The datasheet contained information regarding the patient's age, gender, degree of care needed, medical history, activities of daily living, food type, medications, and oral condition.

Table 2. Information on all patients included in course

Age	Gender	Degree of Care Needed	Medical History	Food Consistency	Remaining Tooth Number	Removable Denture
88	Female	4	cerebral infarction, thoracic vertebra fracture, aspiration pneumonia, asthma	rice gruel, water added thickness	8	yes
90	Female	2	hypertension, cardiac arrest, osteoarthritis of the hip, pneumonia	normal	13	yes
78	Male	4	cerebral infarction, lumbar vertebra fracture, diabetes	normal	2	yes
89	Female	3	infectious spondylitis, lymphadenitis, diabetes	normal	0	yes
80	Male	1	cerebral infarction, cardiac arrest, pneumonia	normal	32	no
85	Female	5	femoral fracture, osteoarthritis of the spine, cataract, kidney calculus	soft food	26	no
89	Female	2	thoracic vertebra fracture, pneumonia	normal	0	yes
75	Female	4	dementia, fibroid of uterus	normal	7	yes
92	Female	3	hypertension, dementia, osteoporosis	normal	22	no

Note: Degree of care needed: 1=walking or standing up, are not stable and need partial help for toileting; 2=difficult to stand up or walk and need partial help for toileting; 3=cannot stand up or walk by themselves and need toileting assistance; 4=difficult to have daily life and need full assistance for toileting; 5=need to have full assistance for the daily life and difficult to communicate.

A self-administered questionnaire (Figure 3) was distributed to the students before and after the course to assess their perceptions about their efficiency in learning terms related to geriatric dentistry and clinical research (items 1 to 6), their attitudes relating to listening to elderly patients and group discussion (items 7 to 10), and their attitudes about and knowledge related to self-study (items 11 to 13). Also, the questionnaire contained blank sections where students could write open-ended comments. The students were informed that the questionnaire results would not influence their course evaluations, but they were asked to write their names on the questionnaire in order to enable data comparison between their responses before and after the PBL course. Differences in the means of the scores before and after the course were evaluated with the Wilcoxon signed rank test. The Sigma Stat 3.11 software (Systat, San Jose, CA, USA) was used for this analysis. The significance level was set at 0.05.

Results

The students tried to identify the patients' needs through direct interviews, as well as to discover approaches to manage them through intragroup discussions. The students also decided the theme of the presentation during group discussion before they presented the patient case to all other members. The themes of all student groups are shown in Table 3. The themes were dementia (two groups), eating conditions (two groups), removable dentures (two groups), quality of life (two groups), and oral care (one group).

It was observed that all scores significantly increased after the PBL course (Figure 4). The score indicating an increase in the knowledge of terms related to geriatric dentistry and clinical research (items 1 to 6) was much higher than the evaluation of attitudes related to listening to elderly patients and group discussion (items 7 to 10) or the evaluation of

	I have never heard/read	I have heard/ read once	I understand but can't explain	I understand and can explain
1. Late-stage elderly	(0)	(1)	(2)	(3)
2. Degree of caregiving	(0)	(1)	(2)	(3)
3. Aspiration pneumonia	(0)	(1)	(2)	(3)
4. Dysphagia rehabilitation	(0)	(1)	(2)	(3)
5. Clinical decision making for patient	(0)	(1)	(2)	(3)
6. Risks and benefits from treatment	(0)	(1)	(2)	(3)

	I can't do at all	I can't do well	I can do	I can do well
7. Listening to elder patient's complaint	(0)	(1)	(2)	(3)
8. Active participation on a study group	(0)	(1)	(2)	(3)
9. Presentation on own study to classmates	(0)	(1)	(2)	(3)
10. Discover and present new findings that the other people can not consider	(0)	(1)	(2)	(3)

	I don't agree	I tend not to agree	Neutral	I tend to agree	I agree
11. My study time was increased	(0)	(1)	(2)	(3)	(4)
12. My study fullness is high	(0)	(1)	(2)	(3)	(4)
13. I need to read previous study reports	(0)	(1)	(2)	(3)	(4)

Figure 3. Students' self-assessment questionnaire

Note: Items 1 to 6: evaluation of knowledge of terms related to geriatric dentistry and clinical research. Items 7 to 10: evaluation of attitudes related to listening to elderly patients and group discussion. Items 11 to 13: evaluation of attitudes and knowledge related to self-study.

Table 3. Theme of each group in the case presentation

Group A: Communication with dementia patients
    A validation method for communicating with dementia patients

Group B: Effect of walking exercise on body and quality of life
    Body exercises for preventing the bedridden condition

Group C: Oral care for elderly patient
    Education on patient's oral care for the facility staff

Group D: Delightful life that the patient can eat sweet bean paste bread
    Tooth and denture brushing is important for eating the favorite food in the future

Group E: Let's go home
    Comparison between living at home and staying at a nursing care facility

Group F: How to eat well for long time
    Educating the facility staff about tooth brushing methods to preserve many teeth

Group G: A case of ill-fitting removable complete dentures
    Suggestion of removable denture adjustments

Group H: Increasing quality of life of elderly patients with dementia
    Dental treatment of the dementia patient who has terrible oral condition

Group I: Case report: removable denture of Ms. T.Y.
    Possibility of using removable denture for dementia patient

attitudes about and knowledge related to self-study (items 11 to 13). In regards to knowledge about geriatric dentistry, 58 percent of the students reported that they understood the term "late-stage elderly," but only 12 percent reported that they understood the term "degree of caregiving" before the PBL course. After the course, 97 percent of the students reported they understood the term "degree of caregiving." In regards to attitudes about group study, the scores for "listen to an elder patient's complaint" and "discover and present new findings that other people did not consider" were not high before the course. In regards to attitudes about self-study, scores on all items were quite high before the PBL course although all of the items showed an increase after the course.

The student comments in the questionnaire's open spaces are shown in Table 4. Interestingly, there were only twelve students who wrote comments before the PBL course, and most of them wrote about their concerns, more specifically that they were nervous or wanted to do their best during the PBL course. After the PBL course, however, a great majority of the students (n=56) wrote some comments expressing their satisfaction and their understanding of the importance of talking with elderly patients and managing their problems.

Discussion

Currently, many countries in the world, including Japan, are facing the aging of their populations, and it is important that dental schools develop training courses on geriatric dentistry to educate students about the needs of elderly patients and give them experience in management approaches as well. Although the importance of these courses is widely recognized, less than 30 percent of dental schools in the United States and Europe offer clinical practices in geriatric dentistry.[5,6]

Okayama University's dental school started a visiting program to elderly nursing care facilities in 2009. In this PBL course, the students interviewed elderly patients at a nursing care facility with the aim not only of providing prosthodontic treatment but also of attending to other aspects related to patients' medical conditions or welfare (e.g., dementia, eating, and quality of life). In Japan, senior citizens exceed 20 percent of the total population,[1,2] and dental students should understand their daily life needs. Elderly patients presenting some sort of physical or mental impairment (e.g., Alzheimer's disease and cerebrovascular diseases) usually search for higher levels of personal care and support at long-term nursing homes. Additionally, these frail elderly or

bedridden patients frequently have some difficulty eating or swallowing due to prosthodontics problems or oropharyngeal dysphagia (e.g., choking, coughing, aspiration of food, or saliva), which eventually may lead to malnutrition and immune system compromise, dehydration, and even aspiration pneumonia.

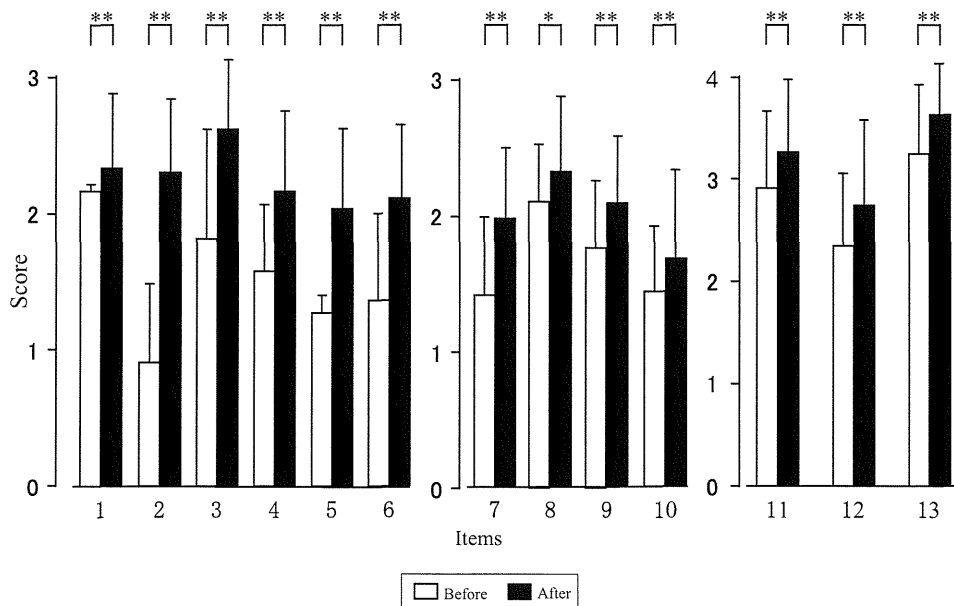The objectives of this PBL course, as shown in Table 1, were achieved. The students were able to un-

Figure 4. Results of assessment of learning efficiency via problem-based learning

Note: Results of the assessment of students' knowledge about and attitudes regarding geriatric dentistry, clinical research, and self-study by comparison of the self-assessment questionnaire administered before and after the PBL course. Total number of students was 65. Data are presented as mean ±SD.

$*p<0.05, **p<0.01$

Table 4. Student comments before and after the PBL course

Before the PBL course
I am nervous.	6 students
I want to do my best.	5 students
I am interested in elder patients' lives.	1 student

After the PBL course
I talked with elderly patients and considered their lives.	13 students
I realized the importance of elderly patient management.	11 students
It was a great course.	8 students
Communication with patients is important.	7 students
Quality of life is important.	4 students
Group discussion is important.	3 students
I am interested in the management of dementia patients.	3 students
I could study the validation method.	1 student
Previous papers are important.	1 student
Presentation is important.	1 student
Searching evidence is difficult.	1 student
Decision making for therapeutic management is difficult.	1 student
Evaluation of patient problems is difficult.	1 student
Interview time was short.	1 student

derstand the concept of the patient-oriented system, to identify the problems of dependent elderly patients living in a nursing home via direct interviews, and to discuss and provide management via group discussion. Finally, all students presented and wrote a case report. For example, one group focused on the importance of systemic physical exercise. The patient was a ninety-year-old female complaining of a sore right knee and ill-fitting removable dentures. The patient had a history of aspiration pneumonia and was in a bedridden condition when she entered the nursing home. After some therapeutic sessions focusing on exercise, the patient recovered and could walk by herself. The students pointed out that her problem was the risk of falling during walks and consequent bone fractures, which, in turn, could cause her to become bedridden. Under these circumstances, the fact that the removable dentures were in an inadequate condition could be a risk factor for or at least increase the risk of aspiration pneumonia. The students concluded that simple physical exercises (e.g., walking around the living area) could be effective for the prevention of and/or recovery from a bedridden condition and, consequently, could improve life satisfaction. Additionally, they mentioned the importance of a well-fitting denture for the patient's eating comfort as well as for the prevention of other conditions, such as difficulty in swallowing and aspiration of saliva or food.

In regards to the assessment of students' knowledge about and attitudes related to medical treatment for the elderly, clinical research, and group discussion, their scores significantly increased after the PBL course. The terms related to gerontology most students reported as understanding after the PBL course included "degree of care needed," "aspiration pneumonia," and "dysphagia rehabilitation." Additionally, most students (57 out of 65=88 percent) had a positive reaction to the PBL course and/or reported an increase in their motivation to study dentistry in the open-ended comments section.

Previous reports have corroborated the importance of such training courses in motivating students to understand elderly patients as well as to learn geriatric dentistry. For example, two studies reported that communication training involving first-year dental students and elderly people became a strong motivation for students to study.[23,24] Additionally, a study found that after fifth-year dental students completed an internship involving nursing and helping patients in a nursing home, 90 percent indicated they had deepened their understanding of the dependent elderly.[13]

It should be noted that the PBL course presented in this study varies from a traditional PBL course. In addition, our study had some limitations. First, this study was limited in that it did not include a control group not receiving the PBL course. We compared student perceptions about their attitudes regarding and the efficiency of learning geriatric dentistry via group study and self-study before and after the PBL course. Since we did not include a control group, we cannot conclude that this PBL course is better than no PBL course. Future studies, with larger numbers of groups, including control groups, should verify whether the results of this study are generalizable. Second, the other limitation of this educational trial was the tight time schedule for round-trip transportation, which, consequently, limited the time for student-patient interviews. Moreover, the selection of the nine patients for this PBL course was performed by the facility staff, who intentionally selected the healthier institutionalized patients. Future studies should attempt to make the schedule more flexible and consider the possibility of students interviewing bedridden patients or those requiring higher levels of care also. Third, it would be more appropriate if students did not need to write their names on the questionnaire; however, we asked them to identify themselves to enable data comparison of responses before and after the PBL course.

Finally, it was concluded that the problems of elderly patients living in health care facilities could be treated even by fourth-year dental students with little or no clinical knowledge. We also found that the students' self-evaluation scores on knowledge about and attitudes toward gerontology, clinical research, and self-study increased after this PBL course.

Acknowledgments

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