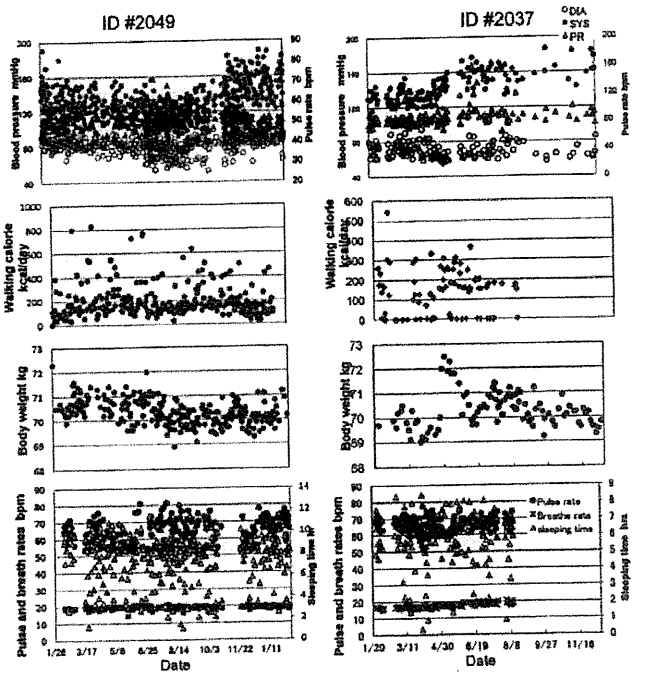

Fig. 4. One-year monitoring of BP, estimated calorie expenditure based on the number of steps walked and exercise training, sleeping conditions, and body weight for the worsened cases, ID#2037 and ID#2049. ID2049 did not get 1 year data for walking calorie and sleeping conditions.

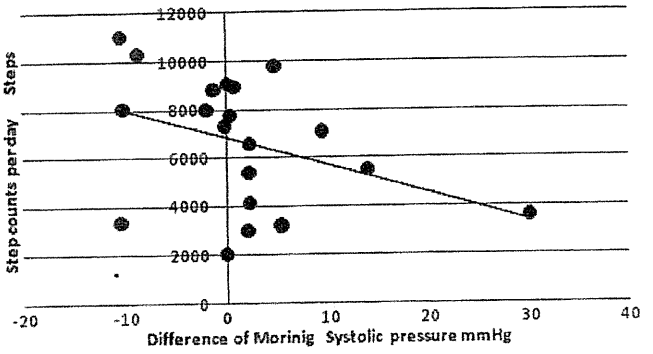

Fig. 5. The relationship between changes in SBP from the first to the last 3 months and steps walked.

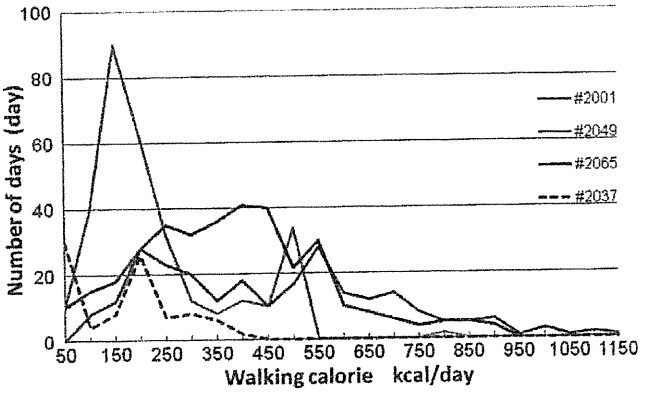

Fig. 6. Distribution of steps walked for the four subjects shown in Figs. 3 and 4.

C. *Results of Multivariate Regression Analysis*

Two cases that showed improvement and two that showed worsening over the study period were analyzed.

In a case showing SBP improvement, ID#2001, the coefficient of determination (R^2) was 0.47. In this case, SBP was reduced by 4.3 mmHg, with a cumulative total energy expenditure of 10 000 kcal by exercise and walking ($t = -9.04$). However, body weight was not a significant index of changes in SBP. ID#2065 showed a lower coefficient of determination ($R^2 = 0.24$). In this case, sleep influenced the morning SBP. SBP declined by 2.0 mmHg with an increase of 1 h in sleeping time. Furthermore, SBP was reduced by 2.5 mmHg with weight loss of 1 kg.

In the case showing worsening of SBP, ID#2037, the coefficient of determination was $R^2 = 0.57$. In this case, SBP increased by 4.1 mmHg, with a cumulative total energy expenditure of 1000 kcal ($t = 5.65$). This lower accumulated energy expenditure was associated with the elevation of SBP. ID#2049 showed a coefficient of determination of $R^2 = 0.43$. In this case, SBP was also increased by 2 mmHg with total energy expenditure of 1000 kcal ($t = 7.93$) and SBP increased by 9.1 mmHg with an increase of 1 kg in body weight.

D. *Evaluation of Walking/Exercise/Energy Expenditure*

Subject ID#2001 showed improvement in SBP, with energy expenditure of 333 ± 159 kcal/day (8805 ± 3756 steps/day) over a period of 346 days. ID#2065 showed energy expenditure of 421.8 ± 215.0 kcal/day (10 126 ± 4342 steps/day) over 241 days. On the other hand, subjects ID#2037 and ID#2029 who showed worsening of SBP had energy expenditure levels of 34 ± 115 kcal/day over 86 days and 194 ± 132 kcal/day over 293 days, respectively. The number of steps walked and estimated energy expenditure were determined from the days on which the subject wore the pedometer. Fig. 5 shows the relationship between changes in SBP and steps walked. The intercept for reducing SBP was around 7000 steps per day.

Fig. 6 shows detailed examples of the distribution of the number of steps walked in the improved and worsened cases.

On average, the energy expenditure of subjects who showed improvements in SBP showed a normal distribution, whereas the distribution of steps for those in whom SBP worsened showed higher proportions of low-level energy expenditure.

IV. Discussion

A. *Participants*

We developed a simple home healthcare system and performed 1-year monitoring for blood pressure control in terms of exercise and sleep. Such 1year monitoring can be troublesome for the subjects, especially the elderly. Our monitoring protocol included a number of restrictions, such as the careful handling of the BP device and monitoring time. Thus, only very limited data were received from the subjects. In fact, only 31 of 61 subjects attempted to measure the physiological parameters more than 150 times. Three of these 31 subjects showed significant

improvement in SBP but two showed significant deterioration of the health condition.

Most previous studies examined the relationship between SBP reduction and exercise, based on data for periods of 6 months. For 1-year monitoring, it is necessary to simplify the handling of medical devices, especially for the elderly.

B. Relationship Between Blood Pressure and Exercise

1) Walking Steps: Our results indicated that higher numbers of walking steps were associated with improved SBP. Paffenbarger *et al.* [11] recommended increasing energy expenditure by 2000 kcal per week to reduce SBP. This is equivalent to 300 kcal per day, which corresponds to the energy expenditure of around 10 000 steps. In previous reports, 12 weeks of walking (average number of walking steps: 13 510 $\pm$ 837 steps/day) showed improvements of 10.2 and 8.4 mmHg in SBP and DBP, respectively [12]. Moreau *et al.* reported that resting SBP was reduced by 6 mmHg ($P < 0.005$) after 12 weeks and was further reduced by 5 mmHg at the end of 24 weeks ($P < 0.005$) [10]. In our studies, ID#2001 showed reductions of 10.4 and 7.0 mmHg in morning SBP and DBP after 1 year, respectively. ID#2065 also showed reductions of 8.7 and 5.1 mmHg in morning SBP and DBP, respectively. These results support the findings reported by Moreau *et al.* [10]. Additionally, Fig. 5 shows that a reduction in SBP required that the subject walked for more than 7000 steps per day. This agrees with previous findings [12].

Several intervention studies used periods of 12 or 24 weeks. In case ID#2001, the averaged SBP and DBP were reduced by 14.1 and 5.1 mmHg, respectively, after 24 weeks. However, after 1 year, the SBP and DBP were reduced by 10.4 and 7.0 mmHg, respectively. On the other hand, ID#2065 showed reductions of 3.6 and 4.5 mmHg in SBP and DBP, respectively, after 24 weeks. After 1 year, the reductions were 8.7 and 5.1 mmHg in SBP and DBP, respectively. The rate of reduction differs among individual subjects as well as by season.

With regard to the intensity of walking, MET (metabolic equivalent task) above 3 is recommended to produce health benefits (ACSM/AHA recommendation) [13]. To promote and maintain health, all healthy adults need to engage in moderate-intensity aerobic physical activities, such as walking for a minimum of 30 min per day 5 days a week, or vigorous intensity aerobic activity for a minimum of 20 min per day 3 days a week. In our pedometer study, we could only estimate exercise, based on the number of walking steps per hour. The data for ID#2001 and ID#2065 shown in Fig. 6 suggested that both subjects walked more than 1000 steps/h. However, this result did not indicate large percentages of high intensity physical activity, above 3 METS, with a walking speed of 4 km/h and around 5300 steps/h. Nevertheless, subjects with more than 7000 walking steps per day showed reductions in SBP.

The estimation is also difficult because of the very large degree of variance in the number of walking steps and because constant walking is typically not possible in the elderly, because of daily changes in physical condition and motivation. For example, subjects may not go outside on days when the weather was bad. Thus, they met the recommendations on only some days during the period of monitoring.

2) Physical Strength, Determined Using an Ergometer: ID#2001 attempted to use the ergometer as an exercise tool and performed to the predetermined intensity of 50 W (about 3 METs) 188 times per year. The average exercise time was 29.6 $\pm$ 4.8 min/time and expended 97.1 $\pm$ 17.5 kcal/time. One-third of the reduction criterion of 300 kcal was concentrated in the 30-min exercise test. This exercise was good for the winter when the subjects remained at home. That is, the exercise test is safe and applicable for the elderly because it is an indoor activity.

3) Exercise for the Elderly: The ACSM/AHA recommends resistance training at least twice per week to provide a safe and effective means of improving muscular strength and also frequent exercise to improve BP. However, elderly subjects have an increased risk of injury and other adverse events, and therefore exercise must be performed carefully. In a systematic review of studies performed to evaluate the associations between pedometer use and changes in physical activity and health outcomes, Bravata *et al.* [14] reported that the mean intervention duration was 15.2 weeks, and that no evidence was available regarding whether the changes associated with pedometer use were maintained over the long term.

Several conclusions based on the results of this study are as follows:

1) If the subject performed the exercise with a total energy expenditure of 300 kcal, the BP was reduced over a period of 3 months.
2) The number of walking steps showed a large degree of variation and the subjects walked after assessing their conditions.
3) The intensity of exercise is an important factor in maintenance and reduction of SBP. To maintain muscle strength, suitable exercise in the home is required. A simple exercise machine that shows exercise intensity is needed at home.

It is important to develop guidelines that will encourage individuals at highest risk to maintain and reduce their BP. The type, frequency, intensity, and period of exercise are important points for improving the quality of life.

Finally, we have developed a system for monitoring blood pressure and other physiological parameters simultaneously. We tried to monitor a large number of subjects over 1 year, but we could analyze only four subjects precisely. The main reason for the lack of data was subject motivation, as the monitoring proved inconvenient for the subjects. Furthermore, if the subject's data did not differ much from day to day, he or she lost interest in long-term monitoring. Further development of the system should explore two main themes: developing a simple device for blood pressure monitoring and analyzing long-term physiological data in terms of its value in predicting and preventing disease.

V. Conclusion

We have developed a simple home healthcare system with a unique transmission system, with which we performed a 1-

year field trial. The system performed without serious problems, but only 31 of 61 subjects provided sufficient data for statistical analyses. Among these 31 subjects, we carefully analyzed cases that showed both improvements and worsening of BP. The results indicated that subjects with energy expenditure of more and less than 300 kcal showed reduction and elevation of BP, respectively. We conclude that exercise is the most important factor in reducing BP. The improvements and changes in daily activity with or without intervention are important factors, and it is necessary for the subjects to have the motivation to make changes in their daily life. Although we recruited a relatively large number of subjects in the present study, the amount of effective data obtained was relatively low. Further improvements to the home healthcare system are required to enhance the subjects' motivation to monitor their health condition more extensively.

REFERENCES

[1] G. O. Stergiou, N. M. Baibas, A. P. Gantzarou, I. I. Skeva, C. B. Kalkana, L. G. Roussias, and T. D. Mountokalakis, "Reproducibility of home, ambulatory, and clinic blood pressure: implications for the design of trials for the assessment of antihypertensive drug efficacy," *Am. J. Hypertens.*, vol. 15, pp. 101–104, 2002.

[2] A. Jain and A. L. R. Krakoff, "Effect of recorded home blood pressure measurements on the staging of hypertensive patients," *Blood Press. Monit.*, vol. 7, no. 3, pp. 157–161, 2002.

[3] G. Bobrie, N. Genès, L. Vaur, P. Clerson, B. Vaisse, J.-M. Mallion, and G. Chatellier, "Is 'isolated home' hypertension as opposed to "isolated office" hypertension a sign of greater cardiovascular risk?" *Arch. Intern. Med.*, vol. 161, pp. 2205–2211, 2001.

[4] T. Ugajin, A. Hozawa, T. Ohkubo, K. Asayama, M. Kikuya, T. Obara, H. Metoki, H. Hoshi, J. Hashimoto, K. Totsune, H. Satoh, I. Tsuji, and Y. Imai, "White-coat hypertension as a risk factor for the development of home hypertension: the Ohasama study," *Arch. Intern. Med.*, vol. 165, no. 13, pp. 1541–1546, Jul. 2005.

[5] R. Sega, G. Trocino, A. Lanzarotti, S. Carugo, G. Cesana, R. Schiavina, F. Valagussa, M. Bombelli, C. Giannattasio, A. Zanchetti, and G. Mancia, "Alterations of cardiac structure in patients with isolated office, ambulatory, or home hypertension data from the general population (Pressione Arteriose Monitorate E Loro Associazioni [PAMELA] Study)," *Circulation*, vol. 104, pp. 1385–1392, 2001.

[6] P. A. Smith, L. N. Graham, A. F. Mackintosh, J. B. Stoker, and D. A. Mary, "Sympathetic neural mechanisms in white-coat hypertension," *J. Am. Coll. Cardiol.*, vol. 40, no. 1, pp. 126–132, Jul. 2002.

[7] R. Sega, R. Facchetti, M. Bombelli, G. Cesana, G. Corrao, G. Grassi, and G. Mancia, "Prognostic value of ambulatory and home blood pressures compared with office blood pressure in the general population: follow-up results from the Pressioni Arteriose Monitorate e Loro Associazioni (PAMELA) Study," *Circulation*, vol. 111, pp. 1777–1783, 2005.

[8] E. A. Young, R. M. Nesse, A. Weder, and S. Julius, "Anxiety and cardiovascular reactivity in the Tecumseh population," *J. Hypertens.*, vol. 16, no. 12, pp. 1727–1733, 1998.

[9] I. Mizukura, T. Tamura, Y. Kimura, and W. Yu, "New application of IEEE 11073 to home healthcare," *The Open Med. Inf.*, vol. 3, pp. 32–41, 2009.

[10] K. L. Moreau, R. Degarmo, J. Langley, C. McMahon, E. T. Howley, D. R. Bassett, and D. L. Thompson, "Increasing daily walking lowers blood pressure in postmenopausal women," *Med. Sci. Sports Exerc.*, vol. 33, no. 11, pp. 1825–1831, 2001.

[11] R. S. Paffenbarger, R. T. Hyde, A. L. Wing, and C. C. Hsieh, "Physical activity, all-cause mortality, and longevity of college alumni," *N. Engl. J. Med.*, vol. 314, no. 10, pp. 605–613, 1986.

[12] M. Iwane, M. Arita, S. Tomimoto, O. Satani, M. Matsumoto, K. Miyashita, and I. Nishio, "Walking 10000 steps/day or more reduces blood pressure and sympathetic nerve activity in mild essential hypertension," *Hypertens. Res.*, vol. 23, no. 6, pp. 573–580, Nov. 2000.

[13] AHA, "Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association," *Circulation*, vol. 116, pp. 1081–1093, 2007.

[14] D. M. Bravata, C. S. Spangler, V. Sundaram, A. L. Gienger, N. Lin, R. Lewis, C. D. Stave, I. Olkin, and J. R. Sirard, "Using pedometers to increase physical activity and improve health: a systematic review," *J. Amer. Med. Assoc.*, vol. 298, no. 19, pp. 2296–2304, 2007.

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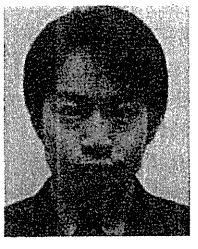

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各　論
糖尿病の運動療法
4．長続きさせるための方法

木村　穣*

はじめに

糖尿病において，運動の効果がEBMとして認められていることは周知の事実であり，食事，薬物介入とともに糖尿病介入の基本である．しかし食事，薬物に比しややその施行率，推進率が劣るのもまた事実である．これは医師のみならず，他のコメディカルにとっても，運動が簡単そうで意外と説明に手間取り，具体的運動内容に踏み込みにくい面もあると思われる．しかし最近の糖尿病や肥満介入の結果によると，特殊な運動ではなく，日常での活動量を上げることで十分な効果を上げることも証明されており，今後の主眼はいかにして日常の活動量を上げるか，維持させるかにあると考えられる．

ところが，日常の活動量になると余計に運動指導として何を指導すればよいのか？　逆に戸惑うことになるのもまた実態である．なぜなら，日常の活動量の具体的な増やし方や評価は意外と困難で，逆に単なる歩数や有酸素マシンの管理の方がまだわかりやすく簡単であるからである．ここで重要なことは，行動医学に基づく認知行動的介入であり，活動量を上げるための個々の患者に合わせた具体的手法を理解しておく必要がある．

本稿ではこの行動医学に基づいた具体的管理方法と，さらに今後の新しい方法としてのITによる遠隔指導についても筆者らの結果を中心に述べさせていただく．

行動医学に基づいた運動療法管理(図-1)

1．行動変容手順の概要

最初のステージ分類は行動変容介入を行う場合，最も基本的な考え方で，医師のみならずすべてのコメディカル職種で応用できる手法である．とくに関心期や維持期のモデルにおいては，この手法は用いやすく応用範囲が広く，本稿でも主に関心期から実行期のモデルにおいての応用につき述べていく．しかし無関心期の対応も重要で，情報提供の手段，内容などについては行動医学の成書などを参照されたい．また，運動に関するス

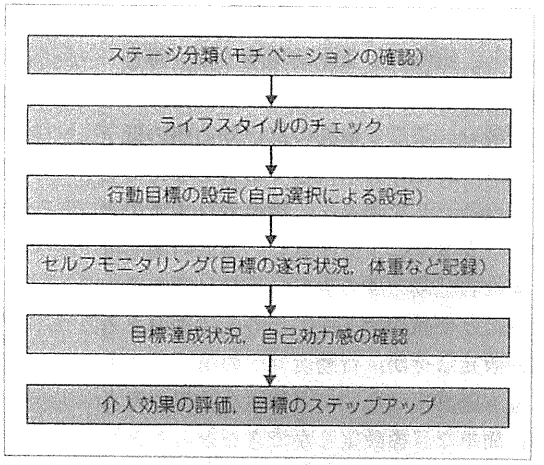

図-1◆行動医学に基づいた行動変容プロセス

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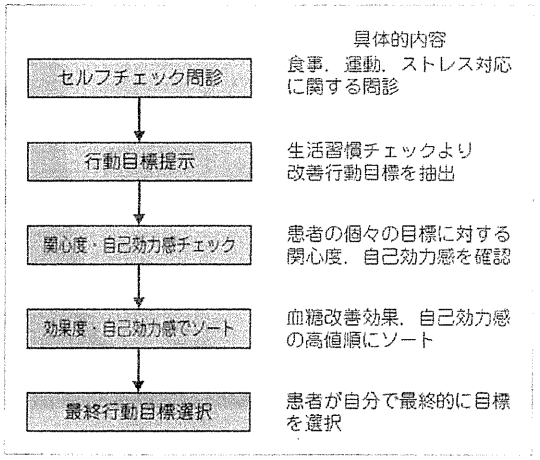


図-2 ⇒IT による行動目標プロセス

テージと食事や疾患に対する考え方のステージなど，各項目により異なることがあり，それぞれの介入内容についてのステージ分類が重要である．

2．関心期の運動療法

a．個人の主体性に基づいた目標設定

関心期においては，個人の生活習慣や性格特性に合わせた目標設定が重要となる．一般に減量や血糖コントロールのみを考えると，最も効果的な炭水化物やアルコールなどの制限や，積極的な運動習慣を行動目標に設定したくなるが，ここで重要なことは患者の主体性の確保であり，決して指導者の満足感を満たすことではない，ということである．とくに初期の運動指導などでは，患者のモチベーションも亢進しており，毎日ジョギングする，一日一万歩など高度な目標を設定しがちである．しかし，実際の日常生活環境では，毎日一定時間の運動の継続はかなり困難で，挫折してしまうことが多い．ここで最初の自己効力感の低下を招き，以後の行動介入に大きく影響を与えてしまうことになる．したがって，指導者は患者の過剰なモチベーションに十分注意し，本人の関心度の低い，また自己効力感の少ない行動目標の設定に陥らないことが重要である．この主体性のある行動目標の設定こそが，行動変容への第一歩であるといっても過言ではない．主体性を重視するあまり最初に簡単な目標設定しかできなかったとしても，その後の運動効果を危惧する必要はない．なぜならその後自己効力感が向上し，運動へのステージが関心期から実行期に移れば，行動目標のステップアップは十分可能となるからである．したがって，この行動目標の設定には十分時間をかけ，慎重に設定する必要がある[1]．

b．ライフスタイルに基づいた行動目標設定

行動目標の設定において，上記の主体性について，個人のライフスタイルや考え方，性格特性に基づいた目標の設定は重要である．したがって個人の生活習慣や家庭，職域環境，過去の運動習慣，運動・日常行動，生活環境に対する考え方なども把握することは，その後目標設定に有用である．これら個人の生活習慣や性格特性などの情報は多いほどその後の目標設定に役立つと考えられるが，逆に多すぎればこれら生活習慣や性格特性の関連や妥当性を理解する指導者スキルも必要となる．

そこで筆者らは，コンピュータ問診システムを用い，まず個人のライフスタイルを詳細にチェックし，そのライフスタイルから逆算した行動目標を抽出し，糖尿病に対する効果の期待できる順に提案し，かつ個人の関心度と自己効力感により自己選択できるシステムを構築し，効果を上げている．とくにコンピュータ問診による行動目標の選択方式では，患者は指導者の目を気にすることなく，自分のできそうな目標を選択できるので，実施に実現可能な目標を選択できる確立が高いと考えられる（図-2）[2]．

c．セルフモニタリング

行動目標の設定の次に重要なことは，目標達成の管理である．この場合，単なる目標達成率の管理に終わると，単調な達成率の評価に終わり，モチベーションの低下を招くが，ここでセルフモニタリングを併用することにより，達成感が向上し行動目標の達成率の向上につながる．したがってここで述べるセルフモニタリングとは，行動目標の進捗状況の管理という意味でのセルフモニタリングと同時に，行動変容に伴う血糖や体重など客観的指標の改善による自己効力感の維持，向上のためのセルフモニタリングという2つの目的が存在する．

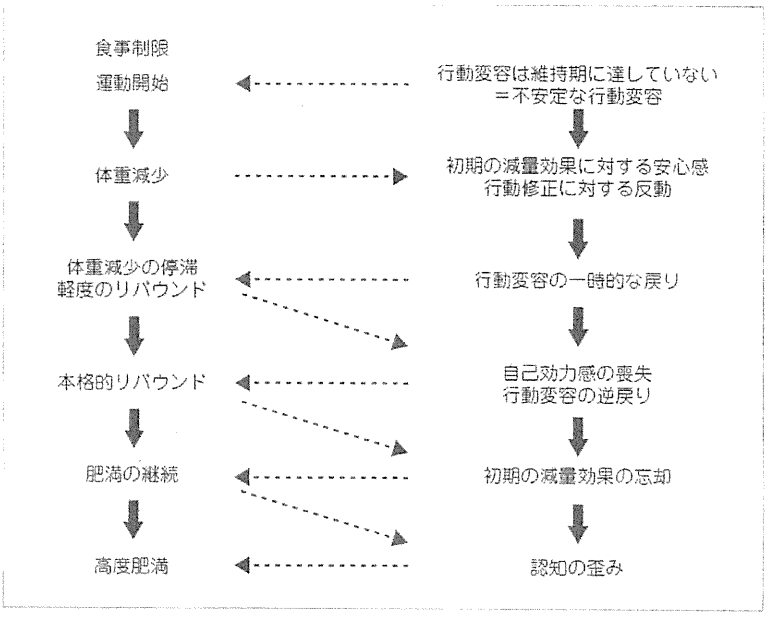


図-3◆肥満例における認知の歪みの機序

d．自己効力感の維持，向上

日常の血糖や体重，歩数などの具体的指標と行動目標の進捗を関連づけることで，患者の自己効力感は大きく向上する．これらセルフモニタリング項目と目標達成状況との関連は，得てして患者本人のみでは関連づけられてないことがあり，積極的に指導者がその関連性を確認し，本人の気づきとして認識させていく必要がある．したがって常に進捗状況が確認できる環境が有用と考えられ，筆者らはITによる行動目標の管理を行い，遠隔監視，指導によるフィードバックシステムを構築し良好な成績を上げている．ITによるセルフモニタリングシステムの概要，効果については後述する．

3．関心期での介入の問題点

・認知の歪み(図-3)

一見関心期にみえるが，実は認知の歪みなどを伴った，いわゆる見かけの関心期も糖尿病ではよくみられ，この認知の歪みを伴った関心期には認知行動療法による介入が必要となる．いわゆる血糖コントロール不良例で，いろいろ治療に関心は示すが，「私は食べていません」，「水を飲んでもやせない」，「運動はしている」などの単純な介入が困難な例である．これらの例では単純なステージ分類での介入を行うとかえって悪化したり，患者との関係性に問題が生じることがある．このような認知の歪みを伴った治療抵抗性では，認知行動療法による介入や，運動療法士や栄養士のみならず，臨床心理士などのカウンセリングによる心理的介入も有効である．すなわち十分なセルフモニタリングにより，生活習慣や運動，食事などと血糖や体重の関連につき確認し，行動変容を妨げる因子を明らかにする必要がある．また，患者の認識と実際の運動や食事が一致して(伴って)いないことや，逆に適切な運動や食事を行えば必ず血糖や体重は改善を示していることに気づかせる必要がある．ただし，この手法も単なる問題点の指摘やできないことの指摘に終わると患者の自己効力感の低下を招くだけであり，患者の認知の歪みを修正し，行動変容につなげるための主体性のある気づきへの導入が重要となる．この認知行動療法による具体的介入方法については，紙面の都合上割愛するが，近年うつや精神疾患のみならず，糖尿病や生活習慣病にも積極的に応用し臨床的効果も確認されており，今後のより積極的な応用が望まれる[3]．

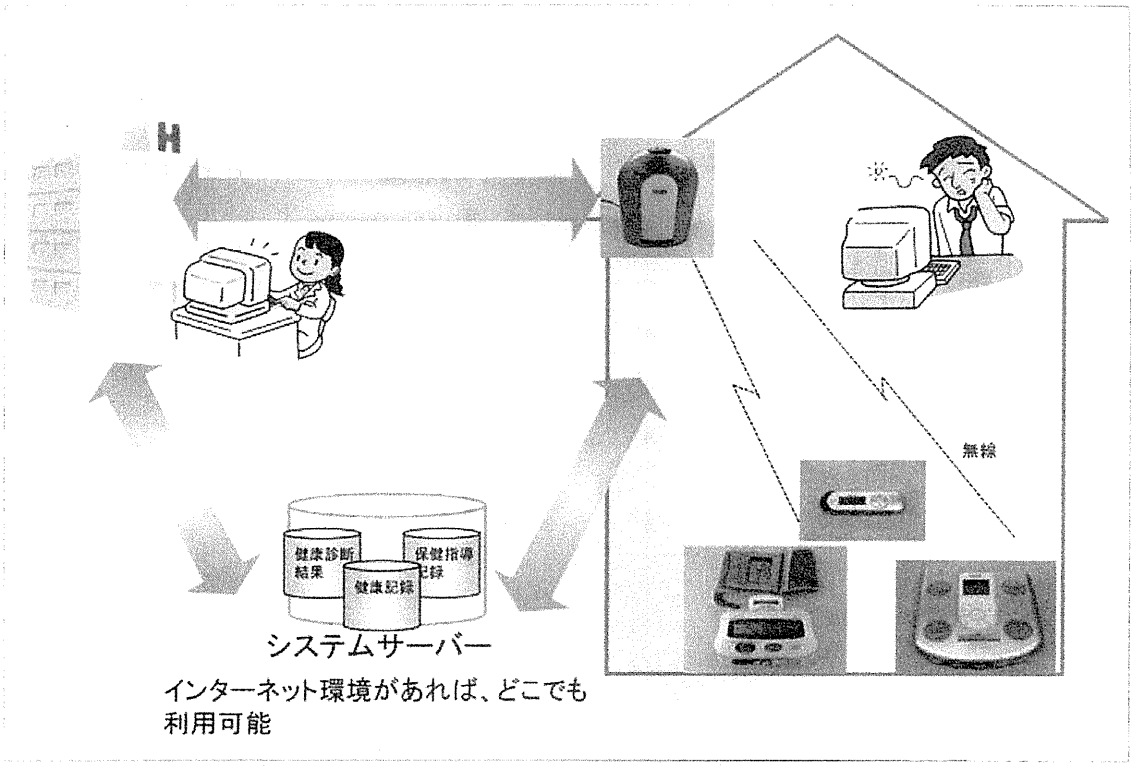


図-4 ◆ITによる在宅健康情報管理システム（資料提供㈱タニタ）
体重計，血圧計，歩数計は家庭内で無線ルーターとつながり，その後LAN回線にて院外のデータサーバーに記録される．データサーバーには，医療機関や院外の指導スタッフなどが，インターネット上でアクセスし，評価．その後患者PCまたは携帯端末にメールにて支援メッセージを送る．

4．維持期の運動療法

a．運動環境の整備

関心期までの運動療法は，主として医療機関や保健指導機関での監視型や積極的な指導での運動が主体となることが多い．しかし，運動療法そのものは継続が重要であり，これら医療機関や保健指導機関での運動療法ではマンパワーや設備的な制限で限界がある．そこで筆者らは既存のフィットネスクラブや行政での体育館などでの運動療法を有効に活用するために，医療機関とのネットワークを構築し，運動処方や運動効果判定にのみ医療機関を利用し，実際の運動療法の継続は外部の運動施設で施行できるシステムを構築している[4]．本システムにより，血糖管理や安全で効果的な運動療法を医療機関と同レベルで，医療機関以外で施行することが可能となし，より効率的な運動療法の継続が可能となる．しかし実際には，医療機関以外での運動指導士の教育や責任などの問題が生じてくる．そのため現在NPOを設立し運動指導士の教育や認定を行い，一定のレベルの運動指導士を確保し，患者のみならず，医療機関側からの信頼も得られるようになり，より積極的な運動療法の推進が可能になってきた．今後はいかに患者の医療情報や運動状況が，医療機関と運動施設において共有されるかが重要な課題であり，この点においても，後述のITの活用が有用と考えられる．

b．運動障害の防止，管理

運動療法の継続において，行動医学的管理は重要であるが，運動器の保護，障害の予防も重要である．とくに中高年の運動習慣の妨げとなる因子として，運動器の傷みや障害は大きな問題であり，内科的疾患に対する運動療法ではあるが，運動器からの管理は非常に重要である[5]．とくに前

述の行動医学的管理が向上すればするほど，逆に運動継続率が高くなり，かえって運動障害による医療費の増加やQOLの低下を招く恐れがあり，内科医といえども運動器の管理には十分留意する必要がある．変形性膝関節症(OA)を伴う場合は，あらかじめ運動制限や水中運動などに特化した運動療法が施行できるが，症状のない場合の運動開始による痛みなどの症状出現に関しては十分配慮する必要がある．しかし，最近の中高年の運動器の症状の検討では，器質的障害のない場合の運動による痛みについては，ストレッチや適切なコンディショニングなどの教育で十分予防，改善可能との報告もあり[6]，今後これら運動器保護を目的とした運動療法の施行も進めていく必要がある．

c．心血管系事故の予防，管理

運動器とともに，心血管系のリスク管理も重要である．本特集では他稿においてメディカルチェックの詳細な記載があるので，リスク管理，予防についてはそちらを参照されたい．いずれにせよ，疾患患者の積極的な運動療法では，事前の運動負荷試験が必要となる．しかし医療機関での運動負荷試験は，専門医や設備の問題で必ずしも容易ではないことがある．筆者らはとくに運動負荷試験時の心電図管理を目的として遠隔運動負荷監視システムを構築しており，医療機関のみならず一般の運動施設においても，専門医の遠隔監視下での運動負荷試験が可能となり，より効率的な運動負荷試験，運動処方の作成が可能になると思われる[7]．

新しい運動指導ツール：ITによる遠隔運動指導，管理

1．自動セルフモニタリングの有用性(図-4)

前述のごとくセルフモニタリングは，目標行動の遂行，行動変容への自己効力感の向上，維持のために重要である．とくに体重や歩数の記録は，行動変容の変化を時系列で確認でき自己の気づきを促す上でも有用となる．しかし，あくまでも記録がなされることが前提で，記録に対して無関心であったり，記録することへの抵抗がある場合，

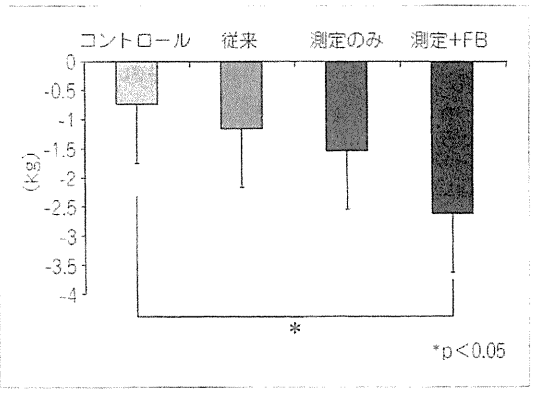


図-5◆IT在宅健康管理システムを用いたRCTトライアルデータ(平成20年度経産省ホームヘルスケア実証事業データより許可を得て改変)
コントロール；健診のみ施行(n=33)，従来；健診後保健指導パンフレットのみ配布(n=23)，測定のみ；家庭用体重計，血圧計，歩数計で記録のみ施行(n=42)．
測定+FB；在宅データを指導員が評価し，行動変容のための支援メッセージを週1回，個別に個人のPCまたは携帯メールに送付(n=54)．
対象：BMI>25，平均年齢51±5.9歳，疾患者は除く．
各群は事前説明による無作為割り付け，各群での年齢，性別，体重，BMIには有意差を認めず，その後3ヵ月間の観察結果(資料提供：㈱富士通BLP)．

このセルフモニタリング手法は困難となる．とくに記録用紙に本人が記録する場合，記録への抵抗やまた，記録用紙の紛失，破損など長期の記録には不備なこともある．また指導者や評価者が記録により，本人への気づきや自己効力感を上げようとする場合でも，紙記録による評価は，本人が紙記録を持参しない限り困難で，1つの限界と考えられてきた．しかし昨今のIT技術の進歩で，在宅にて体重や歩数などを測定するだけで自動転送，記録，外部からの閲覧可能なシステムが開発されるようになった．その結果，患者は体重計や歩数計を装着するのみで，自動的にデータが記録され，かつ指導者側からもデータサーバーにアクセス可能となり，指導者が遠隔で体重や歩数のセルフモニタリング記録を確認し，評価できるシステムの構築が可能となった[8]．従来，行動医学におけるセルフモニタリングは自己の気づきを促すための手法であり，単なる測定結果の自動記録では，行動変容につながらないとされてきたが，指導者(評価者)がセルフモニタリングデータを確認

し，本人にフィードバックすることで新たな気づきが生じ，行動変容に結びつくことが確認されている(図-5)[9]．したがって，無関心期であっても，単純な体重測定や歩数記録のみであれば行動目標として設定できる可能性があり，新たな行動変容ツールとしても期待されている．

2．在宅運動療法システムの開発

運動療法においても，日常の活動量を上げることが重要であり，特別な運動プログラムの継続的な遂行は困難と述べたが，実際に家庭での運動で，かつゲーム的な要素を含む場合，運動の継続や運動の効果を得ることが可能と報告されている[10]．筆者らも同様のシステムで運動量を自動的に記録し，かつ指導者が運動量につき携帯やPCメールで評価，支援した場合，良好な運動継続を認めており，今後の検証が期待されている．

今後の運動療法の方向

1．運動療法継続におけるインセンティブの考え方

行動変容継続のもう1つの方法は，いかにその行動にインセンティブをつけるか，ということも行動医学的に重要である．単純な褒め言葉や賞賛も重要であるが，継続ということを考えるとインセンティブも有用である．一方，インセンティブにはそのための費用負担が必要であるが，すでにアメリカの大手検索エンジンサイトでは，保険事業者と提携し，医療費の軽減で見込める余剰金をITヘルス費用に転化することで利用者にはほとんど追加費用かからずにITによる在宅指導や管理を請け負う事業を始めている．これらのごとく，インセンティブは基本的に外部からの導入費用に転化できる可能性があり，今後の開発が望まれる．

2．わが国での具体的対応法

わが国での今後の具体的方法として，健康保険での適応や特定保健指導での適応など医療機関での適応が検討されると思われる．また企業健保としての取り組みも検討されており，企業の生産効率の面からも検討されている．また，地域経済の活性化との関連で，運動療法と地域の健康関連産業との連携なども模索されている[11]．今後さらなるEBMが構築されることにより積極的な運動療法の展開が期待される．

3．運動療法マンパワーの問題

運動療法継続において最後の問題は，だれが運動指導を行うかという点である．糖尿病という疾患を考えた場合，医療スタッフの対応が必要となり，既存の理学療法士や看護師，糖尿病療養指導士の対応が考えられるが，逆に具体的な運動指導ということになると，運動指導士による直接的な指導も重要と考えられる．とくに膝や腰などの運動器の予防も兼ねた運動指導となると実際の運動生理や筋生理を理解した上での指導が必要となる．かつ運動の継続という意味では教育的要素が重要となり，体育系の指導員の活用が望まれる．しかし，現実には体育系の指導員の臨床上の資格がなく，また糖尿病療養指導士に体育系の指導者の受験資格がないことより，臨床の現場での具体的運動指導には限界があるのが現状である．今後，より積極的でかつ安全，効果的な運動療法の継続のためにはこれらマンパワーの問題も改善していく必要がある．

まとめ

糖尿病の運動療法の継続性を高めるための現場でのスキル，制度，環境的側面について述べた．今後これら諸問題が改善され，より快適な運動療法の環境がすべての医療機関，健康増進機関で提供されること望みつつ，稿を終えさせていただく．

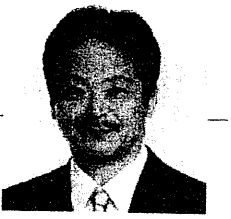
文　献

1) 木村　穣：保健指導のための認知行動療法．臨床スポーツ医学 25：1201-1207，2008.
2) 木村　穣：糖尿病の食事・運動療法，認知行動療法の有用性と限界．糖尿病カレントライブラリー，201-206，文光堂，2007.
3) 熊野宏昭ら：内科臨床に役立つ心療内科的アプローチ　内科医に求められる認知行動療法・メンタルヘルスの基礎知識とは？．Medicina 44(11)：2130-2139，2007.
4) 木村　穣：関西メディカルフィットネスネット

ワーク．治療(増刊号)：1020-1026，2008.
5) Ito, K. et al. : Ultrasonographic Changes of the Knee Joint Cartilage Associated with Physical Chracterization in Middle-Aged Women : 6-Month Observational Survey. J. Phys. Ther. Sci. 19 : 277-282, 2007.
6) 松平　浩，笠原　諭：心因性腰痛．腰痛－診療実践マニュアル．整形外科臨床パサージュ1巻(山下敏彦編)．中山書店，2010(in press).
7) 木村　穣：心臓リハビリテーションの安全性確保と緊急時の対応．Journal of Clinical Rehabilitation 別冊．医歯薬出版，249-252，2007.
8) Mizukura, I. et al. : New Application of IEEE 11073 to Home Health Care. The Open Medical Information Journal 44-53, 2009.
9) 木村　穣，岩坂壽二：30歳からの冠動脈疾患の予防戦略のあり方．冠動脈疾患のNew Concept．中山書店，254-263，2006.
10) Graves, L. et al. : Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games : cross sectional study. BMJ 7633 : 282-284, 2007.
11) 三宅眞理ら：ヘルスツーリズムからみた生活習慣病対策．臨床スポーツ医学 25 : 147-154，2008.

Prog.Med.
31:3077～3081, 2010

特集 ロコモティブシンドロームと生活習慣病



5．ロコモティブシンドロームの予防

4）身体活動エネルギー(METs)概念を取り入れたロコモティブシンドローム対策

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はじめに

ロコモティブシンドロームの予防に運動が重要なことは周知の事実であるが，その多くはレジスタンストレーニングによる筋力の増強・維持であり，身体活動やエネルギー消費の面からの検討は少ない．一方，メタボリックシンドロームとロコモティブシンドロームの関連において，過体重による関節，靱帯系への負担はロコモティブシンドロームの発症に大きく関与しているが，最近の研究では，メタボリックシンドロームによる炎症誘発性サイトカインも運動器の炎症に関与しており，従来の過体重のみではなく，代謝性因子によるメタボリックシンドロームからロコモティブシンドロームへの影響も重要と考えられようになってきた[1]．したがって，身体活動の維持，向上はロコモティブシンドロームの予防に十分つながると考えられる．本稿ではこれらの事実を踏まえ，身体活動エネルギーの面からロコモティブシンドロームの予防につき解説する．

METsとは

METs(metabolic equivalent(s))とは，安静座位の酸素摂取量3.5 mL/kg/minを1 METとして，呼気ガス分析などにて測定された酸素摂取量を3.5で除した値であり，運動時の運動強度を，安静時の酸素摂取量の何倍あるかで示す指標となる．したがって，METsは安静時のエネルギー代謝を基準とした相対的運動時エネルギー代謝を評価するため，体重や体力に関係なく，標準化された運動強度を表示できるメリットがある．ここでは同時に健常者の運動指導に用いられているエクササイズの概念についても述べておく．

身体活動とは

身体活動とは，安静にしている状態より多くのエネルギーを消費するすべての身体の動きで，基本的に骨格筋を使用しエネルギーを発生している状態である．したがって日常生活でのすべての活動を含むが，便宜上体力の維持や向上を目的とした意図的なエネルギー消費を「運動」と定義し，運動以外の日常生活でのエネルギー消費を「生活活動」として区別している．通勤や通学，仕事として活動することも生活活動に含まれる．

厚生労働省のエクササイズガイドライン(2006年)[2]や米国スポーツ医学会(ACSM)の運動推奨ガイドライン(2007年)[3]，成人の減量および体重再増加予防のための適切な身体活動に関するガイドライン(2009年)[4]では，この身体活動の増加の重要性を強調している．また，単なる活動量の増加のみではなく，ある程度の体力も健康や生命予後に関連するというエビデンスも蓄積され，身体活動量の強度に関する概念も明確にする必要が出てきている．そこで，前述のMETsの概念が必要となってくる．すなわち，METsによる運動強度の概念を明確にすることにより，日常生活における身体活動量のトータル消費エネルギーと同時に，運動強度の内容についても評価が可能となる．このことは，運動指導を行う上で極めて簡単に活動量を把握でき，かつ実際に行うべき運動強度が算出され，その結果選

表1　3 METs未満の活動(身体活動・運動量の基準値の計算に含めないもの)

METs	活動内容
1.0	静かに座って(あるいは寝転がって)テレビ・音楽鑑賞，リクライニング，車に乗る．
1.2	静かに立つ．
1.3	本や新聞などを読む(座位)．
1.5	座位での会話，電話，読書，食事，運転，軽いオフィスワーク，編み物・手芸，タイプ，動物の世話(座位，軽度)，入浴(座位)．
1.8	立位での会話，電話，読書，手芸．
2.0	料理や食材の準備(立位，座位)，洗濯物を洗う，しまう，荷作り(立位)，ギター：クラシックやフォーク(座位)，着替え，会話をしながら食事をする，または食事のみ(立位)，身の回り(歯磨き，手洗い，髭剃りなど)，シャワーを浴びる，タオルで拭く(立位)，ゆっくりした歩行(平地，散歩または家の中，非常に遅い＝54 m/分未満)．
2.3	皿洗い(立位)，アイロンがけ，服・洗濯物の片付け，カジノ，ギャンブル，コピー(立位)，立ち仕事(店員，工場など)．
2.5	ストレッチング*，ヨガ*，掃除：軽い(ごみ掃除，整頓，リネンの交換，ごみ捨て)，盛り付け，テーブルセッティング，料理や食材の準備・片付け(歩行)，植物への水やり，子どもと遊ぶ(座位，軽い)，子ども・動物の世話，ピアノ，オルガン，農作業：収穫機の運転，干し草の刈り取り，灌漑の仕事，軽い活動，キャッチボール*(フットボール，野球)，スクーター，オートバイ，子どもを乗せたベビーカーを押す，または子どもと歩く，ゆっくりした歩行(平地，遅い＝54 m/分)．
2.8	子どもと遊ぶ(立位，軽度)，動物の世話(徒歩/走る，軽度)．

*印は運動に，その他の活動は身体活動に該当する．

表2　3 METs以上の生活活動(身体活動量の基準値の計算に含むもの)

METs	活動内容
3.0	普通歩行(平地，67 m/分，幼い子ども・犬を連れて，買い物など)，釣り(2.5(船で座って)～6.0(渓流フィッシング))，屋内の掃除，家財道具の片付け，大工仕事，梱包，ギター：ロック(立位)，車の荷物の積み下ろし，階段を下りる，子どもの世話(立位)．
3.3	歩行(平地，81 m/分，通勤時など)，カーペット掃き，フロア掃き．
3.5	モップ，掃除機，箱詰め作業，軽い荷物運び，電気関係の仕事：配管工事．
3.8	やや速歩(平地，やや速めに＝94 m/分)，床磨き，風呂掃除．
4.0	速歩(平地，95～100 m/分程度)，自転車に乗る：16 km/時未満，レジャー，通勤，子どもと遊ぶ・動物の世話(徒歩/走る，中強度)，屋根の雪下ろし，ドラム，車椅子を押す，子どもと遊ぶ(歩く/走る，中強度)．
4.5	苗木の植栽，庭の草むしり，耕作，農作業：家畜に餌を与える．
5.0	子どもと遊ぶ・動物の世話(歩く/走る，活発に)，かなり速歩(平地，速く＝107 m/分)．
5.5	芝刈り(電動芝刈り機を使って，歩きながら)．
6.0	家具，家財道具の移動・運搬，スコップで雪かきをする．
8.0	運搬(重い負荷)，農作業：干し草をまとめる，納屋の掃除，養鶏，活発な活動，階段を上がる．
9.0	荷物を運ぶ：上の階へ運ぶ．

表3　3 METs以上の運動(運動量の基準値の計算に含むもの)

METs	活動内容
3.0	自転車エルゴメーター：50ワット，とても軽い活動，ウェイトトレーニング(軽・中等度)，ボーリング，フリスビー，バレーボール．
3.5	体操(家で，軽・中等度)，ゴルフ(カートを使って，待ち時間を除く)．
3.8	やや速歩(平地，やや速めに94 m/分)．
4.0	速歩(平地，95～100 m/分程度)，水中運動，水中で柔軟体操，卓球，太極拳，アクアビクス，水中体操．
4.5	バドミントン，ゴルフ(クラブを自分で運ぶ，待ち時間を除く)．
4.8	バレエ，モダン，ツイスト，ジャズ，タップ．
5.0	ソフトボールまたは野球，子どもの遊び(石蹴り，ドッジボール，遊戯具，ビー玉遊びなど)，かなり速歩(平地，速く＝107 m/分)．
5.5	自転車エルゴメーター：100ワット，軽い活動．
6.0	ウェイトトレーニング(高強度，パワーリフティング，ボディビル)，美容体操，ジャズダンス，ジョギングと歩行の組み合わせ(ジョギングは10分以下)，バスケットボール，スイミング：ゆっくりしたストローク．
6.5	エアロビクス．
7.0	ジョギング，サッカー，テニス，水泳：背泳，スケート，スキー．
7.5	山を登る：約1～2 kgの荷物を背負って．
8.0	サイクリング(約20 km/時)，ランニング：134 m/分，水泳：クロール，ゆっくり(約45 km/分)，軽度～中等度．
10.0	ランニング：161 m/分，柔道，柔術，空手，キックボクシング，テコンドー，ラグビー，水泳：平泳ぎ．
11.0	水泳：バタフライ，水泳：クロール，速い(約70 m/分)，活発な活動．
15.0	ランニング：階段を上がる．

択できる運動内容の抽出が容易となり，行動科学的に行動変容への介入が容易になる．

表に代表的な身体活動，スポーツのMETs値を示す(**表1～3**)．

具体的身体活動指導

一般的な運動としては，歩行や自転車運動などの有酸素運動が有用であるが，これらの運動はほぼ3～4 METs(安静時の3～4倍の強度)に相当する．しかし，最近のエビデンスでは，中強度以上の運動強度の運動の有用性が認められており，従来の有酸素運動といった概念的な推奨から，より具体的に運動強度や時間，頻度を明確にした内容に変わってきている．同時に，日常生活での身体活動による消費エネルギーの確保も重要としている．すなわち，積極的な運動活動を得にくい現代人にとって，より効率的に身体活動を確保するための具体的な行動指針となっている．

また，運動強度のみではなく，消費エネルギーをより重要視するために，厚生労働省は，2006年にエクササイズガイドラインにおいて，運動強度を表すMETsに対し，身体活動量を表す指標としてエクササイズ(Ex)を制定している．これはMETsの応用版で，運動強度に運動時間をかけたものとして計算される．エクササイズ(Ex)＝(METs・時)×(量の単位；時間)となり，例えば，

3メッツの身体活動を1時間行った場合：3 METs×1時間＝3エクササイズ(METs・時)

6メッツの身体活動を30分行った場合：6 METs×1/2時間＝3エクササイズ(METs・時)

となる．

従来，運動の消費量としてカロリー(kcal)が用いられており，現場ではやや混乱するが，カロリーを用いる場合，個人の体重により消費カロリーに差が生じ，個人の運動量を体重に関係なく表示するために，このエクササイズ(Ex)の単位が設定された(**図1**)．このエクササイズ単位から消費エネルギーを計算する場合，

運動時消費量(kcal)＝1.05×エクササイズ×体重で

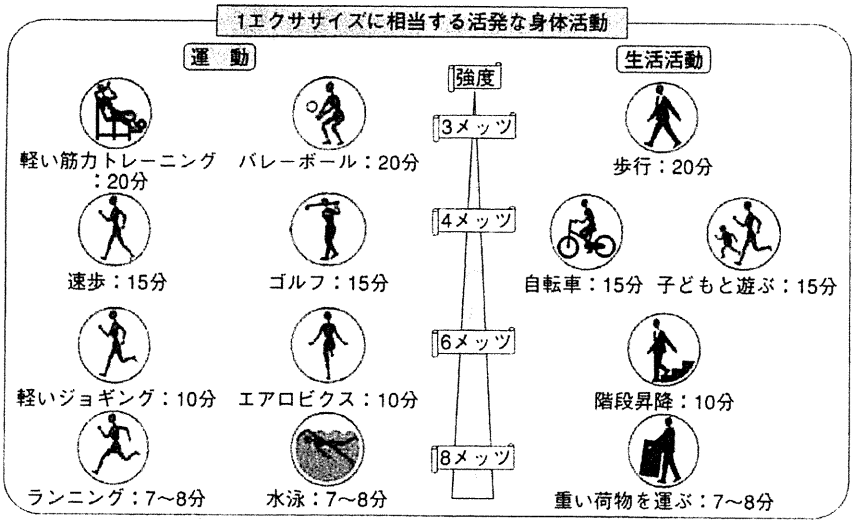

図1　1エクササイズに相当する活発な身体活動

表4　身体活動目標(2007年ACSM)

18～65歳の成人の良好な健康状態を維持するための目標
1．身体活動性のあるライフスタイルを維持.
2．中強度の好気的(持続：endurance)運動を最低30分週5日，もしくは高強度(vigorous)好気的運動の最低20分週3日.
3．中強度・高強度運動の組み合わせ，例えば，週2回30分の早歩きとそれ以外の日は20分のジョギングなど.
4．中強度好気的運動(早歩き等)を，1回10分以上継続し，合計30分まで継続して積み重ねる.
5．加えて，筋力と耐容性を維持・増加させるため，少なくとも週2回は身体の大きな筋肉の運動を行う.
8．体重増加を予防するには身体活動の最小推奨量以上に行う.

消費カロリーが算出可能となる.

また，このエクササイズガイドラインでは，健康づくりのための身体活動量として，週に23エクササイズ以上の活発な身体活動(運動・生活活動)を行い，そのうち4エクササイズ以上の活発な運動を行うことを勧めている.

これらのエクササイズ単位の概念は，従来の運動強度と時間，頻度を基本とした運動処方の定義からやや外れるものであるが，あくまで健常者の健康増進のための身体活動量の目標として，特にメタボリックシンドロームを中心とした肥満者指導の現場で用いやすいように開発されており，健常者の身体活動量の指標としては理解しておく必要がある.

その後，ACSMはエビデンスとして，2007年に中強度の有酸素運動を最低30分週5日，もしくは高強度有酸素運動を最低20分週3日行うことを推奨している.同時に日常生活での軽強度の運動，すなわち，ウォーキングや家庭での家事労働による軽い労作も推奨運動に加えている(表4)．体重増加に関しては，中等度の身体活動を150分/週以上，減量には中等度の身体活動を約250～300分/週(約2,000 kcal/週)を推奨している(2009年)．さらにACSMでは，高齢者の運動にも言及しており，運動の安全性の確認，運動強度については低強度からの漸増法，転倒リスク(バランス)改善のためのレジスタンストレーニングなども推奨している.

また2009年には，より積極的な減量のための身体活動指針として，軽度の身体活動は1.1～2.9 METs，中等度の身体活動は3.0～5.9 METs，強度の身体活動は6 METs以上と定義し，体重増加の予防には週150～250分の中等度(3.0～5.9 METs)の運動が有用であるとしている．しかし，減量には十分でなく，適度な食事制限が必要と述べている．したがって予防的運動の場合，

中等度の運動を週150分以上とし，肥満者の場合，中等度の運動を250～300分施行する必要があるとしている．

ここで注意すべきことは，肥満者の場合，運動時に膝や腰にかかる負担が大きく，かえってロコモティブシンドロームを助長したり増悪する可能性があることである．同時に，メタボリックシンドロームの合併や，既に心筋梗塞などにより心機能が低下し運動耐容能が低下している場合は，より低い運動強度が要求される．特に中高年の循環器，動脈硬化性疾患のリスクの高い例では，安全で効果的な運動を行うために，運動負荷試験による個々の運動耐容能の評価，運動時の循環器系の異常のないことを確認しておく必要がある．

まとめ

身体活動の評価としてのMETsの概念，およびその具体的内容，有用性につき述べた．これら身体活動の具体的運動量，強度，頻度，内容の把握が，メタボリックシンドロームの予防につながり，その結果，過体重や炎症性サイトカインなどによるロコモティブシンドロームの発症を防ぐ可能性が考えられ，従来のレジスタンストレーニングのみならず，身体活動の重要性についても十分認識する必要があると思われる．

文献

1）Iannone F, Lapadula G：Obesity and inflammation-targets for OA therapy. Curr Drug Targets 2010；**11**：586-598.

2）厚生労働省：健康づくりのための運動基準・指針（http://www.mhlw.go.jp/bunya/kenkou/undou.html）.

3）Laurie B：Guidelines Updated for Physical Activity Intervention for Weight Loss Med Sci Sports Exerc 2009；**41**：459-471.

4）Haskell WL, Lee IM, Pate RR, et al；American College of Sports Medicine, American Heart Association, Stanford University, USA：Physical activity and public health：updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation 2007；**116**：1081-1093.

5）Nelson ME, Rejeski WJ, Blair SN；American College of Sports Medicine；American Heart Association：Physical activity and public health in older adults：recommendation from the American College of Sports Medicine and the American Heart Association. Circulation 2007；**116**：1094-1105.

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Psychological factors that promote behavior modification by obese patients

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Abstract

Background: The weight-loss effect of team medical care in which counseling is provided by clinical psychologists was investigated in an university hospital obesity (OB) clinic. Nutritional and exercise therapy were also studied. In our previous study, we conducted a randomized, controlled trial with obese patients and confirmed that subjects who received counseling lost significantly more weight than those in a non-counseling group. The purpose of this study was to identify the psychological characteristics assessed by ego states that promote behavior modification by obese patients.

Methods: 147 obese patients (116 females, 31 males; mean age: 45.9 ± 15.4 years) participated in a 6-month weight-loss program in our OB clinic. Their psychosocial characteristics were assessed using the Tokyo University Egogram (TEG) before and after intervention. The Wilcoxon signed rank test was used to compare weight and psychological factors before and after intervention. Multiple regression analysis was used to identify factors affecting weight loss.

Results: Overall, 101 subjects (68.7%) completed the program, and their data was analyzed. The subjects mean weight loss was 6.2 ± 7.3 kg ($Z = 7.72$, $p < 0.01$), and their mean BMI decreased by 2.4 ± 2.7 kg/m^2 ($Z = 7.65$, $p < 0.01$). Significant differences were observed for the Adult (A) ego state (0.68 ± 3.56, $Z = 1.95$, $p < 0.05$) and the Free Child (FC) ego state (0.59 ± 2.74, $Z = 2.46$, $p < 0.01$). The pre-FC ego state had a significant effect on weight loss ($\beta = 0.33$, $p < 0.01$), and a tendency for changes in the A ego state scores to affect weight loss ($\beta = -0.20$, $p = 0.06$) was observed.

Conclusion: This study of a 6-month weight-loss program that included counseling by clinical psychologists confirmed that the A ego state of obese patients, which is related to their self-monitoring skill, and the FC ego state of them, which is related to their autonomy, were increased. Furthermore, the negative aspects of the FC ego state related to optimistic and instinctive characteristics inhibited the behavior modification, while the A ego state represented objective self-monitoring skills that may have contributed to weight loss.

Background

Behavior modification is essential for the prevention and treatment of obesity, which is one of the critical risk factors for lifestyle-related diseases. However, it is extremely difficult to encourage people to modify their behavior in order to achieve a healthier lifestyle because lifestyles largely depend on individual beliefs and values. For this reason, a behavioral scientific approach would be helpful [1]. It is also important to note that lifestyle-related diseases are closely associated with psychosocial stress [2]. Thus, it is necessary to assess obese patients' psychosocial status and to provide them with psychological support.

Given this background, we started an obesity clinic (OB clinic) in 1999. In the OB clinic, medical doctors, clinical psychologists, registered dietitians, and exercise trainers support obese people, providing team medical care [3,4]. Clinical psychologists assess the patients' psychosocial situation and identify factors that could prevent weight loss. We also try to encourage patients to change their lifestyles by themselves, by maintaining a dialogic relationship aimed at enhancing their self-effectiveness and autonomy. As part of this "team medical care", staff members share patient information and provide comprehensive treatment.

In our previous study, we conducted a randomized, controlled trial with obese patients between 1999 and 2001. In that study, weight was significantly reduced by patients who received counseling from clinical psychologists, as well as nutritional and exercise therapy, compared to patients who received no counseling from clinical psychologists but who received nutritional and exercise therapy. Above all, this study confirmed that subjects who received counseling lost significantly more weight than those in the control group [4].

Based on our previous findings, the purpose of this study was to identify the psychological factors that promoted behavior modification among the obese patients in this program. The psychological factors were assessed using the Tokyo University Egogram (TEG), which is based on transactional analysis theory.

Transactional analysis is a psychological perspective that emphasizes the study of ego states. An ego state is defined as "a coherent system of thoughts and feelings manifested by corresponding patterns of behavior" [5]. Berne defined three principal ego states, each with a specific origin and characteristics: Child (archaeopsyche), Parent (exteropsyche), and Adult (neopsyche) [6]. Further elaboration of ego state theory led to the recognition of two functional Parent ego states (Critical and Nurturing) and two functional Child ego states (Free and Adapted) (Figure 1).

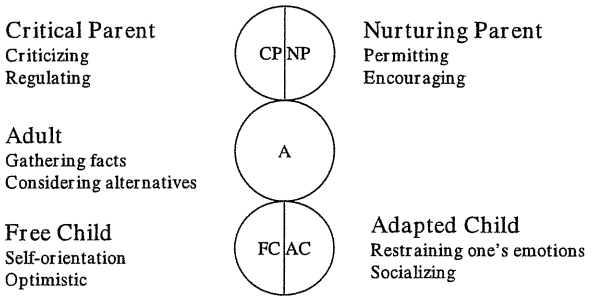

Figure 1
Ego States. Berne defined three principal ego states, each with a specific origin and characteristics: Child (archaeopsyche), Parent (exteropsyche), and Adult (neopsyche). Further elaboration of ego state theory led to the recognition of two functional Parent ego states (Critical and Nurturing) and two functional Child ego states (Free and Adapted). CP stands for Critical Parent, with criticizing and regulating characteristics. NP stands for Nurturing Parent, with permitting and encouraging characteristics. A stands for Adult, focusing on gathering facts and considering alternatives and being objective. FC stands for Free Child, with self-orientation and optimistic characteristics. AC stands for Adapted Child, focusing on restraining one's emotions and with social characteristics.

The transactional analysis theory as described above is an effective therapeutic intervention technique that provides an understanding of human behaviors based on observation and measurements.

Methods and Procedures

Subjects

A total of 147 (116 female, 31 male) patients participated in a 6-month weight-loss program in our OB clinic between 2002 and 2006. At the start of the weight-loss program, the subjects' mean age was 45.9 ± 15.4 years, their mean weight was 85.1 ± 20.7 kg, and their mean BMI was 33.8 ± 7.0 kg/m^2.

In accordance with the Declaration of Helsinki and the ethical guidelines established by Kansai Medical University, all study objectives, as well as data protection and analysis methods, were explained to each subject prior to testing, and written informed consent was obtained. All study protocols were approved by the ethics review board of Kansai Medical University.

Outline of the OB program

In the OB program, patients first saw a physician for a medical consultation, and any patients with obesity attributable to endocrine abnormalities or psychiatric disorders were excluded. Subsequently, the patients under-

went nutrition and exercise therapy as well as psychological counseling (Figure 2).

As part of the nutrition therapy provided by registered dietitians, the Food Frequency Questionnaire (FFQ) was used to determine the subjects' daily food intake at the start of the program [7]. Subsequently, each subject received individual therapy monthly according to the transtheoretical model [8-10].

As part of the exercise therapy provided by exercise trainers, each subject underwent a cardiopulmonary exercise test as described in our previous report [11]. The anaerobic threshold (AT) was determined, an exercise prescription was made at AT intensity, and then the subjects had exercise therapy in the OB clinic two to three times a month. The exercise therapy lasted for 30 minutes and consisted of both aerobic exercise and stretching. In addition, the subjects were educated about home exercise and received instruction on how to exercise at home: Supervised exercise therapy or non-supervised exercise was performed at least three times a week.

All members of the staff exchanged information on each subject and examined their progress for effective support.

Intervention by clinical psychologists

First, the clinical psychologists conducted an intake interview for approximately 50 minutes. During the interview, the clinical psychologists listened and determined the patient's psychosocial status in order to better understand their environment and factors associated with obesity. Specifically, psychosocial status refers to the motivation for and expectation of weight loss, social support, and stress. Lifetime changes in weight were also confirmed. During this process, the clinical psychologists identified psychosocial factors that were related to gaining or losing weight.

As part of the subsequent counseling, transactional analysis therapy using the ego-state model and cognitive behavior therapy to improve self-monitoring skills was used. Specifically, the clinical psychologists integrated information about nutrition, exercise, and psychosocial situation, and they supported the subjects so that they could set objectives about diet, exercise, and lifestyle by themselves. The subjects were then instructed to monitor themselves by recording their weight, pedometer counts, and the degree of achievement based on their own objectives. During the psychological counseling, the clinical psychologists tried to focus on relationships among eating habits, physical activity level, psychosocial status, and changes in weight for each of the subjects, as well as focusing on how

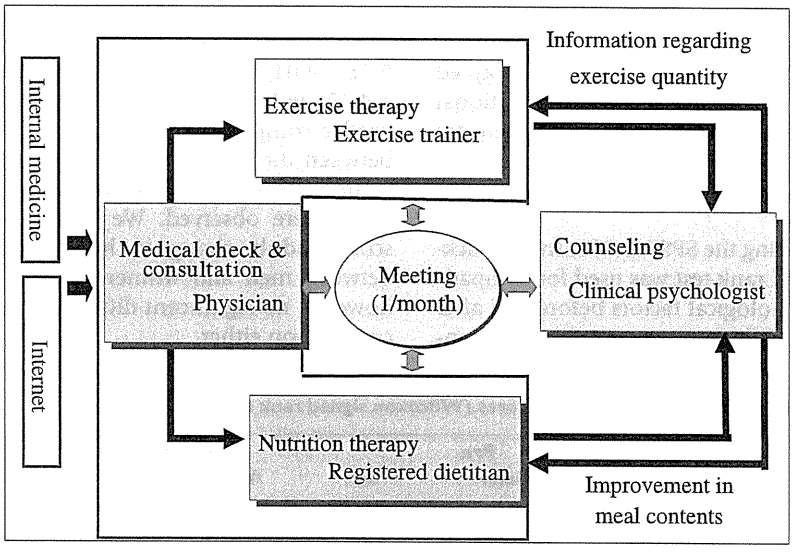

Figure 2

Obesity program. The hospital has a 6-month weight-loss program known as the obesity program (OB program). In this program, physicians, clinical psychologists, registered dietitians, and exercise trainers support obese patients. During the 6-month program, obese patients first consulted with a physician for blood and physical examinations. They then participated in intake interviews about their eating habits with a registered dietitian and about their current psychosocial condition with a clinical psychologist. At least once a month, the clinical psychologists met patients for individual face-to-face counseling. A meeting was held every month to discuss methods to support them and to improve their lifestyles.

much success the subject had in achieving their own objectives. It is important to enhance patients' self-effectiveness and self-control in order to reduce psychological stress and to maintain the weight loss. Therefore, the clinical psychologists respected the patients' autonomy and encouraged the patients to set their own objectives on the basis of the dialogic relationship. In addition, stress management techniques and a relaxation method were also adopted when necessary.

Psychological assessment

During the OB program, psychological characteristics were assessed using several psychological questionnaires. The psychological assessments included the revised NEO personality inventory (NEO-PI-R), which focuses on identifying healthy personality characteristics [12]; the TEG, which measures the ego states [13]; and the Profile of Mood State (POMS), which measures the present mood state [14]. The results from these assessments were then given to the subjects during psychological counseling and used as tools for the subjects to understand how their personalities and stress are related to their eating habits, exercise habits, and weight. Patients answered these questionnaires twice, once when they started the program and once when they completed the program.

In this study, the relationship between the psychological characteristics measured using TEG questionnaires and weight loss was examined. The TEG assessed the energy of each ego state, including Critical Parent (CP), Nurturing Parent (NP), Adult (A), Free Child (FC), and Adapted Child (AC), which are the concepts of the transactional analysis theory. Each ego state has 10 items, so there are 50 items in total.

Statistics

The data was analyzed using the SPSS12.0J software package. The Wilcoxon signed rank test was used for comparisons of weight and psychological factors before and after intervention. The Mann-Whitney test was used to compare the TEG scores at the start of the program between the subjects who discontinued and those who completed the program. Multiple regression analysis was used to identify factors affecting weight loss. The objective variable was the weight loss during the 6-month program. The explanatory variables were age, the number of sessions of nutrition therapy and counseling, TEG scores at the first session (pre-TEG), and the change in the TEG scores before and after intervention.

Results

Change in body weight

Overall, 101 subjects (68.7%) completed the 6-month program. A mean of 6.5 ± 2.3 sessions of nutrition therapy and a mean of 8.0 ± 4.5 counseling sessions were provided to each of the subjects during the program. Exercise therapy was provided at the OB clinic two to three times a month.

The mean weight and BMI at the start of the program of the subjects who completed the program were 83.9 ± 21.0 kg and 33.8 ± 6.9 kg/m^2 respectively. The subjects had a statistically significant mean weight loss of 6.2 ± 7.3 kg ($Z = 7.72$, $p < 0.01$), with weight loss ranging from - 37.6 to 9.2 kg, and a statistically significant mean BMI decrease of 2.4 ± 2.7 kg/m^2 ($Z = 7.65$, $p < 0.01$), with a range from - 12.5 to 3.7 kg/m^2 (Table 1).

Psychological factors for weight loss

The subjects' scores on psychological testing were: CP, 9.78 ± 4.01; NP, 14.60 ± 4.17; A, 10.09 ± 4.49; FC, 12.00 ± 4.47; and AC, 9.52 ± 4.62. The Mann-Whitney test was used to compare the TEG scores at the start of the program between the subjects who discontinued and those who completed the program; however, no significant differences were observed. We also compared the pre-TEG scores and the change in the TEG scores over six months between men and women by the Mann-Whitney test; however, no significant differences were observed in this comparison either.

Table 1: Pre and post weight, BMI, and TEG category scores (Wilcoxon signed rank test).

	Pre		Post			
	Mean	*SD*	*Mean*	*SD*	*Z*	*p value*
Weight	83.89	21.00	77.74	18.07	7.72	< 0.01
BMI	33.80	6.85	31.45	6.12	7.65	< 0.01
Critical Parent score	9.78	4.01	10.39	4.08	1.69	0.09
Nurturing Parent score	14.60	4.17	14.46	4.31	0.44	0.66
Adult score	10.09	4.49	10.77	4.78	1.95	0.05
Free Child score	12.00	4.47	12.59	4.64	2.46	0.01
Adapted Child score	9.52	4.62	9.37	4.52	0.25	0.80

The Wilcoxon signed rank test was used for comparisons of weight and psychological factors before and after intervention.
The TEG scores from the first session (pre-TEG) were compared to those taken on completion (post-TEG) of the program in order to identify changes in these patients' psychological characteristics before and after intervention.

Next, the TEG scores from the first session (pre-TEG) were compared to those taken on completion (post-TEG) of the program in order to identify the changes in these patients' psychological characteristics before and after the intervention. Significant differences were observed for the A ego state (0.68 ± 3.56, $Z = 1.95$, $p < 0.05$) and the FC ego state (0.59 ± 2.74, $Z = 2.46$, $p < 0.01$) (Table 1). The A ego state is associated with gathering facts and considering alternative characteristics objectively, and the FC ego state is associated with self-orientation and optimistic characteristics. Thus, these characteristics of these subjects appear to have been increased by team medical care intervention.

Furthermore, the multiple regression analysis was performed with weight change as the objective variable and age, the number of sessions of nutrition therapy and counseling, pre-TEG scores, and the change in the TEG scores over six months as explanatory variables. The pre-FC ego state had a positive effect on weight loss ($\beta = 0.33$, $p < 0.01$). Thus, the FC ego state, which is related to self-orientation and optimistic characteristics, inhibits weight loss. The A ego state tended to affect weight loss ($\beta = -0.20$, $p = 0.06$). Thus, people who improved their A ego state, which is related to gathering facts and considering alternative characteristics, were able to lose more weight (Table 2).

Table 2: Factors affecting weight loss (Multiple regression analysis).

Explanatory variables	β coefficient	*p value*
Pre weight	-0.58	< 0.01
Age	-0.97	0.37
Number of nutrition therapy sessions	0.01	0.93
Number of counseling sessions	0.08	0.37
Pre-Critical Parent score	-0.06	0.67
Pre-Nurturing Parent score	-0.15	0.25
Pre-Adult score	-0.05	0.75
Pre-Free Child score	0.33	0.01
Pre-Adapted Child score	-0.06	0.57
Change in Critical Parent score	0.18	0.09
Change in Nurturing Parent score	-0.15	0.15
Change in Adult score	-0.20	0.06
Change in Free Child score	0.14	0.18
Change in Adapted Child score	0.14	0.17
$R(R^2)$		0.66 (0.43)

The multiple regression analysis was used to identify factors affecting weight loss. The objective variable was the weight loss during the 6-month program. The explanatory variables were age, number of sessions of nutrition therapy and counseling, TEG scores at the first session (pre-TEG), and the changes in TEG score from the first session to the completion of the program.

Discussion

Change in body weight

Over the 6-month period, the mean weight loss was 6.2 ± 7.3 kg, and the mean decrease in BMI was 2.4 ± 2.7 kg/m^2. We previously reported that weight loss can be more easily achieved in a group in which the subjects received counseling in addition to nutrition therapy and exercise therapy [4]. The results of the present study confirmed that this intervention program for obesity resulted in effective weight loss.

The weight loss should be attributed not simply to the intervention of the clinical psychologists but to the total effect of the intervention of a holistic medical care team in which physicians, registered dietitians, exercise trainers, and clinical psychologists were involved as a team. While supporting the results that a comprehensive cognitive behavior modification method using social learning (group approach), self-monitoring, and exercise was most effective [15,16], the present study confirmed the importance of team medical care.

Psychological factors for weight loss

During the 6-month program, the FC ego state increased significantly; however, the changes in the scores of the FC ego state had no effect on weight loss and the pre-FC ego state was confirmed to prevent weight loss. We examined these results from the perspectives of ego states, each of which have positive and negative aspects. The positive aspects of the FC ego state involve controlling negative emotion and are related to the ability to look on the bright side and do things in one's own style [17], while the negative aspects are not caring about disease and giving in to temptation because of optimism, as well as instinctive and impulsive behaviors. In addition, other studies have reported that some negative emotion has a positive effect on the control of weight and blood sugar levels [4,18]. This study supports these previous findings regarding the relationship between optimism and carelessness in terms of disease prevention behavior modification. Considering the circumstances mentioned above, the negative aspects of the FC ego state prevented subjects from controlling their behavior, while the positive aspects of the FC ego state were increased by team medical care intervention, because the changes in the FC ego state during this program did not prevent weight loss.

The reports by Eysenk, Grossarth-Maticek, and Everitt, and also by Grossarth-Maticek and Eysenk [19,20] also point out that an "object-dependent" personality is a risk factor for disease, and they describe the importance of autonomy training. The enhancement of the patients' FC ego state as related to self-orientation as observed in this study is assumed to indicate that the patients could not only temporarily solve their problems and eliminate cer-