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Implications of the traditional and the new ACSM Physical Activity Recommendations on weight reduction in dietary treated obese subjects

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OBJECTIVE: To assess the acceptance of the traditional American College of Sports Medicine (ACSM) exercise recommendation (20–60 min of vigorous exercise at least three times per week) and of the new, broader Centers for Disease Control (CDC)/ACSM physical activity recommendation (30 min of moderate intensity activities on most days of the week) in an obese population and to elucidate the implications of meeting these recommendations on weight reduction during dietary treatment.
DESIGN: Prospective dietary intervention study of 1000 kcal diet daily.
SUBJECTS: 109 obese subjects (age: 45.6 ± 13.1 y, body mass index (BMI): 38.1 ± 6.0 kg/m^2, (Female/Male: 81/19%)
MEASUREMENTS: The time spent in moderate (3–6 MET, metabolic equivalents) and vigorous (6–10 MET) physical activities was assessed by use of the Stanford-7-Day-Physical-Activity-Recall-Questionnaire, with subsequent allocation of the subjects to one of three physical activity groups: meeting the traditional recommendation (TR), the new recommendation (NR) or neither of both (SED, sedentary subjects). Physical activity level, physical activity energy expenditure, total energy expenditure (based upon the questionnaire) and resting metabolic rate (by standard equation) were estimated at baseline. Body weight was determined at baseline and after a mean of 16.3 weeks of dietary treatment.
RESULTS: The new, broader recommendation was met by twice as many of the obese subjects (34%) as was the traditional recommendation (17%). Weight reduction at follow up (−8.2 ± 6.5 kg, 16.3 ± 4.3 weeks, mean ± s.d.) was positively correlated with the physical activity level at baseline (r = 0.49, *P* < 0.001). Meeting either the traditional or the new recommendation was associated with greater weight loss [−11.9 ± 8.5 kg (TR) and −10.1 ± 6.4 kg (NR), respectively, not statistically significant (NS)] as compared to being sedentary [−6.5 ± 5.2 kg (SED), *P* < 0.05 *vs* both NR and TR].
CONCLUSIONS: Not only participation in vigorous exercise, but also regular engagement in moderate intensity physical activities, as recently recommended by the CDC/ACSM, predicts greater weight reduction during dietary treatment, compared to being sedentary. The new, broader physical activity recommendation appears to be more readily accepted by obese subjects than the former ACSM recommendation on exercise training.

Keywords: physical activity; weight reduction; ACSM; recommendations; obesity

Introduction

The increasing prevalence of obesity in most affluent populations during the past decades has been paralleled by a considerable reduction in daily energy expenditure, mostly from physical activity, which probably contributes more to this problem than any secular changes in energy intake.[1–4] There is clear evidence from observational studies, that physical inactivity predicts body weight gain[5–8] and in most,[9–12] but not all,[13] intervention studies, incorporation of regular exercise into a comprehensive weight loss program augments the achieved weight loss, when compared to dietary treatment alone. It is well known, however, that the long-term adherence to traditional exercise programs, typically based on the recommendation of the American College of Sports Medicine (ACSM) for developing and maintaining cardio-respiratory fitness (that is, 20–60 min of training at 60–90% of maximum heart rate reserve or 50–85% of maximum oxygen uptake for at least three times per week)[14,15] is low, particularly in obese subjects. The dropout rates reported for this group range from 40–70% after 12–18 months of training.[16–18] In fact, only an estimated 14% of the adult US population regularly engage in vigorous physical activities, whereas about two thirds are not regularly active at all.[19,20]

In view of the limited feasibility of vigorous exercise programs and in order to encourage increased participation in physical activity, the Centers for

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Disease Control and Prevention (CDC), in co-operation with the ACSM, issued a new, broader, physical activity recommendation in 1995.[21] It is recommended that 'every (US) adult should accumulate 30 min or more of moderate intensity physical activity on most, preferably all, days of the week'.[21] Moderate physical activity is defined in this recommendation as activity at an intensity of 3–6 MET (metabolic equivalents, defined as the quotient of metabolic rate for this activity and the metabolic rate at rest). This new recommendation is based on growing scientific evidence that for the purpose of health promotion, it is not essential to engage in exercise as vigorous as that promoted by the former ACSM recommendation.[14,15] Hence, the new recommendations are regarded as a paradigm shift from the traditional 'exercise–fitness' paradigm, towards a broader 'physical activity–health' paradigm.[19,22]

In respect of the treatment for obesity, several experts have previously recognised the potentially beneficial implications of this new understanding of exercise.[23–25] Most appropriately, the new dictum finds relevance in the concept of 'Metabolic Fitness' put forward by Després and Lamarche.[25] However, since the release of the new CDC/ACSM recommendations in 1995, only a limited number of studies have been published that further elucidate the implications of the new concept of physical activity in the management of obesity.[26,27]

In this prospective study, we evaluated by questionnaire, how many obese subjects, who consecutively referred to our obesity clinic between March 1996 and May 1997, initially met either the traditional ACSM exercise recommendation and/or the new CDC/ACSM physical activity recommendation. Thereafter, we followed this cohort over the course of a dietary intervention program, in order to investigate the impact of physical activity levels and different physical activity patterns on the attained weight reduction.

Methods

Out of 137 obese subjects, who consecutively attended the obesity clinic of our hospital between March 1996 and May 1997 to participate in a dietary weight loss program, 127 were enrolled into this study. The remaining 10 were excluded due to either incomplete baseline examinations or insufficient completion of the activity questionnaires. The study was approved by the local ethical committee of the University of Düsseldorf.

Baseline examinations

Medical examination. Initially, all patients were subjected to a thorough medical examination comprising a medical history, physical examination, ECG, laboratory tests and the measurement of height and weight.

Assessment of physical activity patterns and energy expenditure. The Stanford-7-Day-Physical-Activity-Recall-Questionnaire[28–30] was used to obtain various measurements of physical activity and energy expenditure while resting metabolic rate (RMR) was approximated using the equation of Harris and Benedict.[31,32] The recall procedure of this questionnaire has been described in detail elsewhere.[29,30]

Briefly, the participants were asked to recall the daily amount of time spent in sleep, moderate, hard and very hard activities during the five weekdays and two weekend days of the previous week. Each activity category was illustrated to the participants by a list of examples containing common activities of daily life. The time spent in light activities was calculated as the difference between 24 h and the total time spent in the four recalled categories. MET-values (working/resting metabolic rate) of 1 (sleep), 1.5 (light), 4 (moderate), 6 (hard) and 10 (very hard) were used to characterise the average intensity of each category's activities. The energy expended in each category (working metabolic rate) was then estimated from the recalled time and the corresponding MET-value.

Two different equations were used for this calculation, the standard formula as published by Blair *et al*[29] and a weight-adjusted equation as recently proposed by Racette *et al.*[33] In the standard formula, the energy expended within each category (EE_{cat}) is simply calculated as multiples of RMR[29]:

$$EE_{cat} = [t_{cat} \cdot RMR] \cdot [MET_{cat}]$$

where t_{cat} = time (h) spent in the respective category, RMR = resting metabolic rate ($kcal \cdot h^{-1}$) and MET_{cat} = metabolic equivalent of this category.

(While an estimate of $1\,kcal \cdot kg^{-1} \cdot h^{-1}$ was used for calculation of RMR in the original publication,[29] the Harris and Benedict equation[31] was used in the present study). In a validation study by Racette *et al*[33] using the doubly labelled water (DLW) method, this original equation was found to underestimate energy expenditure (EE) in obese subjects. It was hypothesized that this is because the original equation does not account for the increased energy cost of physical activity, contributed by excessive body weight. We therefore also used the weight-adjusted equation proposed by these authors, which includes body weight, namely for the calculation of the incremental energy cost of physical activity:[33]

$$EE_{cat} = [t_{cat} \cdot RMR] + [t_{cat} \cdot (MET_{cat} - 1) \cdot bw \cdot (1 kcal \cdot kg^{-1} \cdot h^{-1})].$$

where bw = body weight (kg).

Thereafter, total daily energy expenditure (Total EE) and the daily EE resulting from physical activity (physical activity EE) were estimated for both equations by summing energy expenditure values across the respective categories. Physical activity levels (PAL) were calculated by dividing the estimated total EE by the approximated RMR.

In an extension of the original recall process, each participant was asked to explicitly describe the character, duration and intensity of every moderate or vigorous physical activity that he or she had engaged in, within the past seven days. Based on this information, all participants were assigned to one of the following three groups:

1. TR-group (traditional recommendation): participation in vigorous activities (6–10 MET) for ≥ 20 min at least three times a week, irrespective of the time engaged in moderate activities.
2. NR-group (new recommendation): participation in moderate physical activities (3–6 MET) for ≥ 30 min at least five times per week, without fulfilling the traditional recommendation.
3. SED-group (sedentary): meeting neither the traditional, nor the new recommendations.

The recall procedure was conducted in accordance with the original protocol as used in the Stanford-Five-City-Project,[28,29] but administered within a group of 6–8 subjects as recently validated by Darroch *et al.*[34] The recall procedure was supervised by one of two interviewers, who had been trained in the standardized recall process.[29,30] All questionnaires were analysed by one investigator (CW) within one week of the recall process.

Weight loss intervention

The weight loss program began with a 3 h group education session, conducted by a registered nutritionist. The participants were instructed to weigh their food, assess their daily energy intake (by use of a calorie table) and record every meal in a diary throughout the course of the program. The dietary intervention consisted of a mixed, self-composed, low calorie diet containing approximately 1000 kcal and a minimum of 50 g of protein. The program was supervised by a nutritionist and a physician who saw the patients 2 – 4 times a month. None of the subjects participating in this study received any advice to change his or her physical activity patterns during treatment.

Statistical analysis

Analysis of variance (ANOVA) was used to compare the three groups at baseline and at follow-up (Tukey's Studentized Range test). Pearson correlation coefficients were calculated to quantify relationships between measurements of physical activity and weight reduction at follow up. Results are given as mean ± standard deviation (s.d.).

Results

After a mean follow up of 16.3 weeks, body weight was reassessed in 109 of the 127 subjects. Eighteen subjects discontinued the program within one month and were excluded from the analysis.

Baseline characteristics

The baseline characteristics of the total study population and of the three subgroups are given in Table 1. The majority of the participants (80.7%) were female. The initial body mass index (BMI) ranged from 29.3–64.2 kg/m^2 (4% with BMI <30 (grade 1 overweight), 62% with BMI between 30–39.9 (grade 2) and 34% with BMI >40 (grade 3), according to the classification proposed by the World Health Organisation (WHO) expert committee in 1995.[35]

Table 1 Baseline characteristics and follow-up data of the total study population and of the three physical activity groups. Values not sharing a common lower case letter are significantly different ($P<0.05$). The three groups were comparable at baseline in respect to gender distribution, body weight, body mass index (BMI) and resting metabolic rate (RMR), but differed in respect to physical activity. At follow-up, weight reduction was higher in the two active (NR- and TR-) groups, compared to the sedentary (SED) group

	Total population *n = 109 (100%)*	*SED-group* *n = 67 (61.5%)*	*NR-group* *n = 23 (21.1%)*	*TR-group* *n = 19 (17.4%)*
Baseline characteristics				
gender (women/men)	88/21	53/14	19/4	16/3
age (y)	45.6 ± 13.1	48.3 ± 12.1^a	43.4 ± 14.2^{a,b}	39.0 ± 14.1^b
body weight (kg)	107.3 ± 19.3	105.2 ± 16.8	109.4 ± 24.7	112.1 ± 20.2
BMI (kg/m^2)	38.1 ± 6.0	37.4 ± 4.8	39.6 ± 8.2	38.9 ± 6.7
RMR (kcal/d)	1820 ± 309	1774 ± 291	1847 ± 307	1950 ± 349
Total EE (kcal/d)	2919 ± 572	2738 ± 410^a	3053 ± 577^b	3439 ± 687^c
Physical activity EE (kcal/d)	1099 ± 319	946 ± 170^a	1206 ± 294^b	1489 ± 359^c
Physical activity level	1.60 ± 0.08	1.54 ± 0.08^a	1.65 ± 0.08^b	1.76 ± 0.08^c
Follow-up				
duration (weeks)	16.3 ± 4.3	17.6 ± 4.2^a	15.2 ± 5.0^{a,b}	14.1 ± 5.0^b
weight loss (kg)	−8.2 ± 6.5	−6.5 ± 5.2^a	−10.1 ± 6.4^b	−11.9 ± 8.5^b
weight loss per month (kg)	−2.3 ± 2.0	−1.8 ± 1.5^a	−3.0 ± 1.8^b	−3.8 ± 2.7^b

EE = energy expenditure.

Of the 109 participants, 19 (17.4%) initially met the traditional recommendation (TR-group). Fourteen of these subjects simultaneously met the new recommendation, that is, only five subjects within this group exclusively met the traditional recommendation (Figure 1). Twenty-three (21.1%) of the participants fulfilled only the new recommendation (NR-group), that is, the total proportion of subjects meeting the new recommendation was 33.9% ($n = 37$). Of the study population, 67 subjects (61.5%) met none of the two physical activity recommendation and were classified as sedentary (Figure 1). There were no differences among the three groups in regard to gender distribution, initial body weight, BMI, and RMR (Table 1). The mean age of the TR-group, however, was lower compared to the SED-group ($P < 0.05$), but not compared to the NR-group (Table 1).

The weight-adjusted values of physical activity EE, total EE and PAL, were higher than those obtained by the standard formula (Table 2). However, the results from both equations were closely related to each other (Table 2, individual data for PAL shown in Figure 2). Since all the findings were consistent irrespective of the equation used, the following analyses all refer to the weight-adjusted data on physical activity.

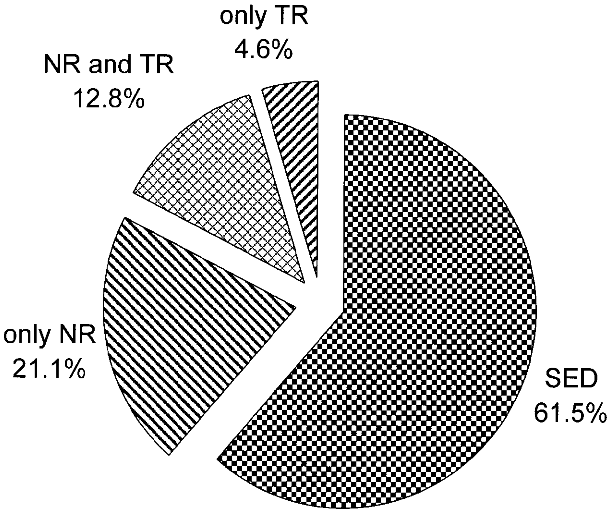

Figure 1 Relative proportions of 109 consecutive obese subjects undergoing dietary treatment, who were sedentary (SED) or met either the traditional, more vigorous American College of Sports Medicine (ACSM) recommendation on exercise (TR) and/or the new, broader Centers for Disease Control (CDC)/ACSM recommendation on physical activity (NR). Note that 14 subjects (12.8%) simultaneously met both recommendations, that is, a total of 17.4% of the subjects met the traditional and 33.9% the new, broader recommendations.

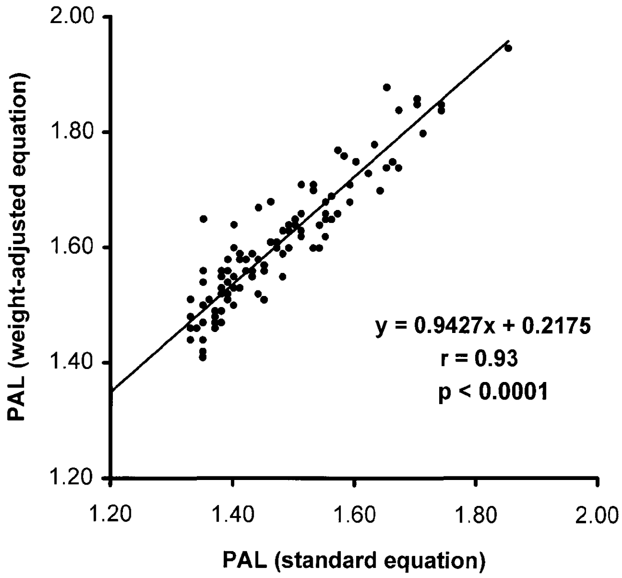

Figure 2 Relationship between physical activity level (PAL), as determined by either the standard[29] or a weight-adjusted[33] equation for the Stanford-7-Day-Physical Activity-Recall Questionnaire. PAL was higher for the weight-adjusted equation, which accounts for the additional energy cost of physical activity, caused by the excessive body weight in obese individuals.

Table 2 Comparison of various measurements of physical activity, obtained by either the standard[29] or a weight-adjusted[33] equation for the analyses of the Stanford-7-Day-Physical Activity-Recall Questionnaire

	Total population	*SED-group*	*NR-group*	*TR-group*
Total daily EE (kcal/d)				
Standard equation	2679 ± 549	2476 ± 390	2813 ± 506	3228 ± 666
Weight-adjusted equation	2919 ± 572	2721 ± 410	3053 ± 577	3439 ± 687
r (Pearson correlation coefficient)	0.99	0.98	0.99	0.99
Physical activity EE (kcal/d)				
Standard equation	858 ± 298	702 ± 142	966 ± 211	1278 ± 336
Weight-adjusted equation	1099 ± 319	946 ± 170	1206 ± 294	1489 ± 359
r (Pearson correlation coefficient)	0.97	0.91	0.96	0.99
Physical activity level				
Standard equation	1.47 ± 0.12	1.40 ± 0.06	1.52 ± 0.04	1.65 ± 0.08
Weight-adjusted equation	1.60 ± 0.08	1.54 ± 0.08	1.65 ± 0.08	1.76 ± 0.08
r (Pearson correlation coefficient)	0.93	0.85	0.85	0.93

Correlations for all parameters shown were significant at the $P < 0.01$ level. SED = sedentary; NR = new recommendation; TR = traditional recommendation; EE = energy expenditure.

Physical activity EE, total EE and PAL, differed significantly between the three groups, with the lowest values in the SED-group and the highest in the TR-group (Table 1). Within the TR-group, physical activity EE tended to be higher in those subjects who simultaneously met the new recommendation (1549 ± 327 kcal/d, $n = 14$), compared to those who exclusively met the traditional recommendation [1330 ± 432 kcal/d, $n = 5$, not statistically significant (NS)]. The physical activity patterns of the 18 subjects, who discontinued the program, did not differ from those of the final study population.

Follow-up
After a mean follow-up of 16.3 weeks, the average weight loss of the study population was 8.2 ± 6.5 kg ($P < 0.05$), which represents a 7.6% reduction of initial body weight (Table 1). As shown in Figure 3, weight reduction was significantly related to PAL at baseline ($r = 0.49$, $P < 0.001$). The same correlation was found for weight reduction per month ($r = 0.49$, $P < 0.0001$), that is, when weight loss was adjusted for the duration of dietary treatment. The correlation remained significant after adjustment for age and initial BMI in a multivariate analysis. Weight loss was not related to age ($r = 0.10$, NS) or BMI ($r = 0.36$, NS) and did not differ between men and women [-8.4 ± 7.2 kg (m) *vs* (-8.1 ± 6.1 kg (w)].

For comparison of the three groups, the respective data for follow-up duration, absolute weight reduction and weight reduction per month are given in Table 1 and Figure 4. Both the TR- and the NR-groups achieved a greater absolute weight reduction than the SED-group (Table 1, Figure 4), although the latter had the longest duration of follow up. Consequently, the differences in weight loss among the three groups were even greater when expressed in kg per month (Table 1). There were no differences in weight loss between the TR- and the NR-groups, even

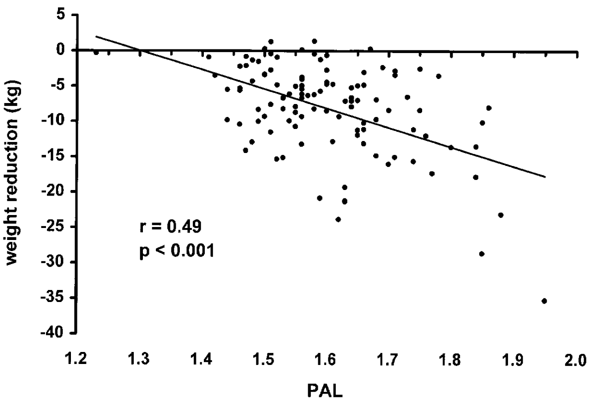

Figure 3 Relationship between physical activity level (PAL) at baseline and consecutive weight reduction during dietary treatment in 109 obese subjects, who participated in a dietary weight loss program for an average of 16.3 weeks. A high level of physical activity was associated with greater weight reduction ($r = 0.49$, $P < 0.01$) and this correlation remained after adjustment for age, initial body mass index (BMI) and duration of treatment.

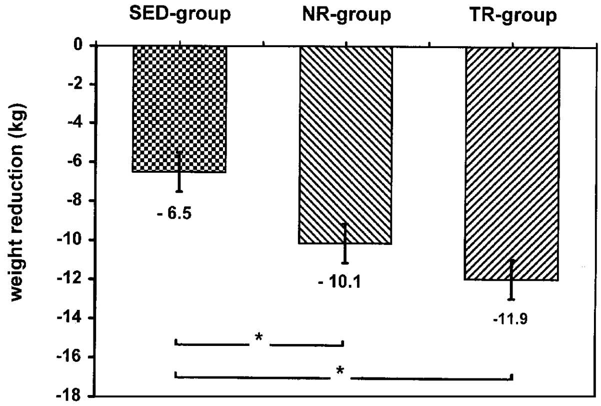

Figure 4 Weight reduction after participation in a dietary weight loss program for 109 obese patients, who were either sedentary (SED-group, $n = 67$) or met the new (NR-group, $n = 23$) or the traditional (TR-group, $n = 19$) ACSM Physical Activity Recommendations (mean ± s.e.m.). Meeting either recommendation was associated with greater weight loss compared to being sedentary (*$P < 0.05$). There was no significant difference in weight reduction between the NR- and TR-group, although the majority of subjects in the TR-group simultaneously engaged in moderate activities, and hence had a higher physical activity level. Comparable results were obtained, when weight reduction was expressed per month (see text and Table 1).

though weight reduction tended to be greater in the former (Figure 4). Within the TR-group, weight loss tended to be greater in the subjects who simultaneously met the new recommendation (-12.3 ± 7.7 kg), compared to those who solely met the traditional recommendation (-10.7 ± 9.1 kg), but this trend did not reach statistical significance.

Discussion

A sedentary lifestyle is a common characteristic within the adult population of most affluent societies. In the US, for example, two recent nationwide surveys have found the relative proportion of inactive or not regularly active adults ranging from 60.1–65.5%.[19,20] Only an estimated 14–16% of this population regularly participates in vigorous, and 20–23% in sustained, leisure-time physical activities.[19,20]

The first aim of the present study was to assess the relative proportions of sedentary, moderately and vigorously active individuals in a group of obese subjects, who were referred to our obesity clinic to participate in a dietary weight reduction program. We found the relative proportions of the different activity patterns to be comparable to those estimated for the general (US) adult population,[19,20] that is, even using the new, broader criteria, about two thirds of the obese population studied was sedentary. However, the proportion of active individuals in this study was twice as high when determined under the new, broader CDC/ACSM criteria (34%) than it was under the traditional criteria (17%). This finding confirms the common opinion that moderate intensity physical activities may be more readily accepted, particularly by obese subjects, than vigorous exercise.[23,24] Of note, the majority of vigorously active individuals simultaneously engaged in moderate intensity physical activities, that is, met both activity recommendations. This has to be taken into consideration when comparing the acceptance rates of the two kinds of activities.

We used the Stanford-7-Day-Physical-Activity-Recall-Questionnaire for assessment of physical activity patterns, because it has repeatedly been validated[36–38] and today is widely used in both epidemiological and clinical studies.[30] Its validity for group administration, as applied in our study, has recently been demonstrated by Darroch *et al.*[34] To ensure a reliable assignment to the different physical activity groups, we extended the original protocol by an explicit recall of the frequency, duration and type of any moderate and vigorous physical activity. The possibility of such kinds of extension of the Stanford questionnaire by specific questions, is regarded as one of its major advantages.[30]

The average physical activity level (PAL) obtained by either the standard equation[29] or by the weight-adjusted formula of Racette *et al*,[33] was 1.47 and 1.60, respectively. The latter value is in closer agreement with the PAL that is usually reported by studies using the DLW technique, currently the most accurate method for the determination of free-living physical activity EE.[39,40] Thus, our data support the hypothesis that weight-adjustment may be necessary when applying the Stanford questionnaire to obese populations. However, despite the absolute differences in estimated physical activity EE, the results from both equations appear to be closely correlated. We did not apply our questionnaire to lean control subjects and thus, our data cannot provide direct information on whether obese individuals are less, equally, or even more, physically active than normal-weight subjects.

The second aim of our study was to prospectively determine the impact of different physical activity patterns on weight reduction during the course of a dietary weight loss program. The average weight loss in our study of 8.2 kg in 16 weeks is in good agreement with the average outcome of solely dietary interventions, as reported in two recent meta-analyses.[41,42] We did not find the achieved weight reduction to be related to age or initial BMI, which is in accordance with our previous findings on the predictors of successful dietary weight loss.[43] In contrast, weight loss was strongly correlated with the initial physical activity level, independent of age, gender and initial BMI, and subjects from both the NR-group and the TR-group achieved a greater weight loss than sedentary individuals. There was no significant difference in weight loss between the NR- and TR-groups, although physical activity EE and PAL were higher in the latter. The highest weight loss was achieved in those individuals of the TR-group, who simultaneously met the new recommendations (-12.2 kg). However, this weight reduction was not significantly different from the weight loss achieved by the other subjects, who met only one of the physical activity recommendations. In the interpretation of this subgroup analyses, however, it is important to take the limited sample size into account.

The weight reductions in these two active groups were 10.4 kg and 11.9 kg, respectively, which is comparable to the average weight loss reported by intervention studies in which exercise was included as an adjunct to the diet.[41,42] In regard to exercise, however, our study was not interventional and, therefore, cannot prove a causal relationship between PAL and weight loss. On the other hand, the observational design may be of potential advantage in this context, since habitual physical activity, as recalled in this study, is likely to be a more consistent measure than the transient activity levels achieved by temporary exercise interventions.

We did not re-administer the physical activity questionnaire at follow-up and, therefore, we cannot control for changes in physical activity that may have occurred during the course of the weight reduction. In the DLW studies of Racette *et al*[33] and Kempen *et al*,[40] however, weight reduction was not accompanied by relevant changes in physical activity EE in obese women.

A methodological shortcoming in the interpretation of PAL in our study is that the estimation of RMR by standard equation does not consider the inter-individual variability of this parameter, which remains, even after adjustment for body size, age and gender. This variability in RMR has been identified as a major predictor of weight control itself[44] and consequently, its estimation by standard equation may limit the validity of PAL in predicting weight reduction. On the other hand, the relationship between physical activity and successful weight loss was even closer in our study when physical activity EE was used instead of PAL.

Conclusion

In summary, our results suggest that not only participation in vigorous exercise, but also regular engagement in moderate physical activities predicts greater weight reduction than being sedentary, in obese individuals during dietary treatment. The recommendation of moderate physical activities, as recently released by the CDC and the ACSM appears to be more readily accepted in obese subjects than the traditional recommendation of vigorous exercise training.

These findings may confirm the new concept for the beneficial health effects of moderate physical activity and, especially, may point out its potential implications for the treatment of obesity.

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