Journal of Physical Activity and Health, 2005, 2, 51-62

Background and Intensity of the GALM Physical Activity Program

Johan de Jong, Martin Stevens, Koen A.P.M. Lemmink, Mathieu H.G. de Greef, Piet Rispens, and Theo Mulder

Background: The Groningen Active Living Model (GALM) was developed to stimulate physical activity in sedentary and underactive older adults. The GALM physical activity program was primarily based on an evolutionary–biological play theory and insights from social cognitive theory. The purpose of this study was to assess the intensity of the GALM program. *Methods:* Data from 15 GALM sessions were obtained by means of heart rate monitors. *Results:* Data of 97 program participants (mean age: 60.1 y) were analyzed. The overall mean intensity for the GALM program was 73.7% of the predicted heart rate maximum and 6% of the monitored heart rate time could be classified as light, 33% as moderate and 61% as hard. *Conclusions:* The GALM program met the intensity guidelines to increase cardiorespiratory fitness. The intensity and attractiveness of this physical activity program make it an interesting alternative for stimulating physical activity in sedentary and underactive older adults.

Key Words: sedentary, underactive, older adults, leisure-time physical activity program

As in other western countries, the prevalence of physical inactivity among older adults constitutes a potential health burden for Dutch society.[1-3] Although many community-based physical activity stimulation strategies have been conducted, only a few focus specifically on enhancing physical activity in sedentary and underactive older adults, a group that could benefit most from such strategies.[4-6] To meet this need for more tailored approaches, a novel strategy termed the Groningen Active Living Model (GALM) was developed.

GALM is a behavioral change strategy for stimulating leisure-time physical activity participation in sedentary and underactive older adults 55 to 65 years of age. The strategy aims at stimulating and monitoring adults who are willing to participate (or resume participation) in leisure-time physical activity. The GALM strategy lasts for a period of 1.5 y and has been described in detail elsewhere.[7,8] Part of the GALM strategy is the physical activity program which can be characterized as a leisure-time physical activity program with an emphasis on recreational sports

de Jong, Lemmink, de Greef, Rispens, and Mulder are with the Institute of Human Movement Sciences, University of Groningen, 9700 AD Groningen, The Netherlands. Stevens is with the Dept of Orthopedics, Groningen University Hospital, 9700 RB Groningen, The Netherlands.

activities (e.g., softball, dance, self-defense, swimming, and athletics).[9] The goal of the GALM program is to stimulate sedentary and underactive older adults to become and remain active in leisure-time physical activity once a week. We hypothesize that, by providing a versatile leisure-time physical activity program that is, on average, of moderate intensity, participants will gain or regain enjoyment during leisure-time physical activities and develop preferences towards certain activities. When the GALM program succeeds in its role as a "trigger," it can cause a transfer in participants becoming physically active more frequently outside the GALM program.[10,11] When this transfer occurs, former sedentary or underactive older adults might increase their frequency of moderate to vigorous physical activity and finally meeting the recommendations for enhancement of health and fitness.[12]

To change the participants' sedentary or underactive behavior, the attractiveness of the physical activity program was an important starting point of GALM. Many interventions have been set up to enhance physical activity among older adults and improve their health status and functional performance. Although scientific evidence shows that these interventions can indeed be successful in enhancing the health and fitness levels of the participants,[13] persuading older adults to become and continue to be physically active remains a difficult task. To assist the maintenance of physical activity in the GALM groups, it was assumed that interventions should be tailored to the individual's wishes, preferences, and needs.[6,14,15,16] To this end, the versatile sport and leisure-time activities of the GALM program[14,15] were based on the evolutionary–biological play theory[17] and insights of social cognitive theory.[18]

The evolutionary–biological play theory suggests that programs that are in accordance with the genetic potential of humans are most likely to succeed in developing a lifelong, physically active lifestyle. Therefore, this theory states that motor systems could be optimally developed and maintained if the motor qualities of strength, speed, endurance, flexibility, and coordination were trained using motor actions such as walking, running, jumping, batting, throwing, and catching that were integrated into games, sports, and activities of daily living. This type of programs would also have to meet three conditions: a) safe environments would have to be created in which participants do not experience feelings of fear; b) the activities conducted should be slightly ambivalent, which means that exciting situations should be included without being too exciting; and c) curiosity should be stimulated or the desire to explore new activities.[17] When these three conditions are met, a situation is created in which self-efficacy, social support, and perceived fitness could be manipulated and ultimately lead to increased enjoyment in physical activity.[7] In the GALM program, self-efficacy was developed by offering activities designed to provide successful mastery experiences. For example, the program had a low starting level with respect to the intensity and difficulty of the activities presented to participants, therefore making almost everyone feel at ease about their ability to participate. In addition, game rules and materials needed (e.g., balls) were adjusted to participants' capabilities when necessary.[7,18] Social support and social interaction were stimulated by support of other GALM group members, feedback from the instructor, and the moment of social interaction that was planned at the end of each session. Finally, feelings of perceived fitness were influenced by letting the participants experience that they were capable of being physically active for longer periods of time at a higher intensity in the course of the GALM program.

Another reason for the versatility of GALM was that in this way the program also addressed several dimensions of motor fitness such as cardiorespiratory and muscular fitness as well as flexibility, all of which are crucial for older adults living independently.[19,20] To enhance health and fitness outcomes, physical activity interventions should meet a certain amount and quality level of exercise. According to the 1998 American College of Sports Medicine (ACSM) recommendations, exercise to increase cardiorespiratory fitness should be conducted 3 to 5 d/wk with an intensity of 55 to 65% to 90% of maximum heart rate, or 40 to 50% to 85% of heart rate reserve, or maximum oxygen uptake with a duration of 20 to 60 min. The lower intensity values are most applicable to individuals who are quite unfit.[12] The purpose of the present study was to investigate whether the GALM physical activity program, which was primarily based on an evolutionary–biological play theory and insights of social cognitive theory, was able to meet the physiological intensity guidelines to enhance cardiorespiratory fitness of sedentary or underactive older adults.

Methods

Participants and Procedures

Subjects in 3 Dutch municipalities were included in this study. The 3 municipalities were selected based on their degree of urbanization. All participants had been recruited using the specific recruitment method of the GALM strategy,[7,21] and started with the GALM program at the same time. The participants in this study were from 5 different GALM groups in 3 municipalities. A total of 4 to 6 different GALM sessions were monitored per municipality, resulting in data of all 15 sessions. During each of the 15 sessions, heart data was obtained from 5 to 10 randomly selected participants. Subjects who used medication that influenced heart rate (e.g., beta blockers) were excluded from participation. In this way, a total of 114 older adults were measured in the 6-month period the GALM sessions were conducted. Mean heart rate data will be presented per session. The main characteristics of the subjects were gathered and body fat was predicted using leg-to-leg bioelectrical impedance analysis (Tanita model TBF-300, Tokyo, Japan). This method proved reliable in measuring body fat percentage and results correlated highly with body fat percentages as measured with underwater weighing and dual-energy x-ray absorptiometry.[22] Before the measurements took place, each subject read and signed an informed consent approved by the Medical Ethical Board of Groningen University Hospital.

Heart Rate Monitoring

Heart rate monitoring of the participants was conducted and analyzed to assess the intensity of the GALM program. Heart rate monitoring has been commonly employed as an objective method of assessing intensity of physical activity.[23-26]

The use of heart rate as a measure of physical activity is promising because it is a physiological parameter known to have a strong positive association with energy expenditure during large-muscle dynamic exercise.[27] Heart rate monitoring has been shown to be valid, and within-subject reproducibility to submaximal upper and lower body exercise is quite high (intraclass correlation coefficients 0.23 to 0.89 and 0.91 to 0.95, respectively).[28,29]

The net time we monitored heart rate of the participants ranged from 54 to 60 min per session, which had a maximum duration of 60 min. A 15-s interval period was used for the heart rate recording, and the data were obtained by means of Polar heart rate monitoring devices (Accurex and Vantage models, Polar Electro, Tampere, Finland). The data were transferred from the Polar receiver to a computer by means of an interface for further analysis.

Structure of the GALM Program

The GALM program consisted of 15 sixty-min sessions, at a frequency of once a week. The selected leisure-time sport activities of the GALM program were based on national survey results on preferences of older adults towards certain leisure-time sport activities. The favorite leisure-time sport activities were incorporated into the GALM program (Table 1).

Each GALM session was structured as follows: a) a warming-up period of 5 to 10 min in which activities such as walking, exercise-to-music routines and introductory activities were linked to exercises to be conducted later in the session; b) 20 to 25 min of skills practice in which the offered exercises were tailored to the level and needs of the participants, and, if necessary, adapted materials were used (e.g., foam balls); c) 20 to 25 min of playing in which the learned and practiced skills were used in the context of a game or other activities; d) 5 to 10 min of cooling-down consisting of flexibility and relaxation activities. After each session, a 15 min moment of socializing was incorporated to strengthen the social interaction and cohesion of the group. During this brief period, the instructor evaluated the session with the participants and gave answers to specific questions and the participants were able to engage in informal conversations with each other while having a drink. All the sessions were conducted in groups of 15 to 24 participants. The sessions were led by a trained instructor who, besides being a professional sports educator, had to complete a 3-d course to learn how to teach the GALM sessions.

The GALM program was conducted at a local gymnasium in or near the neighborhoods in which the participants lived. By means of this neighborhood-oriented approach, GALM tried to make use of participants' social networks. Another bonus of this approach is that participants often lived within walking or cycling distance of the gymnasium, which lowers a barrier for participation.

Statistical Analysis

All data were analyzed with SPSS version 10.0 (SPSS, Inc., Chicago, IL). The first screening for abnormalities in the heart rate curves showed that data of 17 participants (15%) were too damaged; these files were excluded from further analysis. Criterion for exclusion was more than 10 consecutive missing or unusable heart rates. Finally, heart rate data for 97 older adults were eligible for analysis in this study.

Table 1 Recreational Sports Activities of the GALM Program in Chronological Order

Session	Recreational sports activities	Examples of exercises
1	Introductory/ ball game	Introduction of instructor, participants and GALM program. Warming-up with walking, running exercises in small groups to learn each other's names. Ball-throwing and catching, playing introductory game of softball.
2	Softball	Warming-up to music, rhythmical walking, running, arm swinging and jump exercises. Ball-throwing and catching combined with running and batting with small groups. Playing adapted form of indoor softball.
3	Dance	Warming-up to music with increased intensity like arm and leg swings. Learning some steps and moves (e.g., V-step, side-step, step-tap) followed by more intensive exercises like jumping, tripling, skipping, muscle-strengthening exercises for abdomen, buttock and legs, ending with stretching.
4	Volleyball	Warming-up individually throwing and catching volleyball or foam ball, pair-wise exercises. Playing mini-volleyball with adjusted rules.
5	Self-defense	Warming-up to music, exercises with wooden stick like swinging, jumping, balancing the stick on fingers, pulling and pushing, stick wrestling, defense and attack combination (cautiously).
6	Badminton	Warming-up to music, low-impact exercises and stretching. Teaching badminton skills and playing badminton with partner of same level.
7	Basketball	Warming-up with a basketball, dribbling and scoring on basket. Circuit of basketball exercises (set shot, lay-up, chest pass) and playing mini-basketball.
8	Swimming	Aqua jogging, wet-belt exercises and swimming.
9	Soccer	Warming-up exercises with ball, dribbling. Soccer circuit with shooting, dribbling and passing. Playing mini-soccer with special rules.
10	Indoor hockey	Warming-up by means of simple hockey skills, pushing and stopping the ball, playing mini-hockey (adapted rules and materials, e.g., longer hockey sticks, lighter/soft ball).
11	Games circuit	Warming-up to music, introduction of game skills. Playing the circuit with exercises like throwing, catching, walking, running, kicking, jumping.
12	Fitness (in a gym)	Warming-up to music with low-impact and stretching exercises. Introduction of fitness equipment and exercises. Circuit of exercises with light weights. Relaxation and stretching to music.

(continued)

Table 1 (*continued*)

13	Tennis	Warming-up to music doing dynamic flexibility exercises like swinging of arms and legs, walking/running and throwing/catching tennis ball with partner. Tennis skills individually like bouncing on racket, with walking with tennis ball/foam ball/balloon. Playing tennis with adjusted rules.
14	Korfball[a]	Warming-up with ball together with partner throwing, catching during walking and running. Scoring on basket. Playing an adapted form of mini korfball.
15	Athletics	Warming-up with walking, running, stretching and dynamic flexibility exercises. Interval running, javelin throwing/tennis ball. Aiming and throwing javelin/ball on targets (e.g., balloons). Team relay running.

[a]Korfball is a traditional mixed-team ball game that aims at scoring on the basket of the opposite team that is positioned on a 12-ft high pole. The ball has to be played by hand and no physical contact is allowed.

Descriptive statistics were used to analyze the main characteristics of the subjects and the heart rate data. The heart rate data were categorized as light, moderate, or hard according to the ACSM 1998 classification, which was based on the percentage of maximum heart rate (HR_{max}). The HR_{max} was predicted by the formula HR_{max} = 220 – age (in y).[30] The "light" category was defined as ≤ 54% of HR_{max}, "moderate" was 55 to 69% of HR_{max} and "hard" was ≥ 70% of HR_{max}.[12]

Results

The 97 study participants (47% men, 53% women) had a mean age of 60.1 y (standard deviation = 3.7). The main characteristics of the study sample are shown in Table 2.

Results of the heart rate monitoring show an overall mean heart rate for the introductory program of 117.8 beats/min (standard deviation = 8.2). Heart rates varied between a minimum mean of 103.3 beats/min (standard deviation = 8.3) for the fitness session and a maximum mean of 132.9 beats/min (standard deviation = 11.8) for the korfball session. Overall mean percentage of HR_{max} was 73.7% (standard deviation = 5.1). Mean percentages of HR_{max} varied from as low as 64.6% (standard deviation = 5.2) for fitness to as high as 83.1% (standard deviation = 7.4) for korfball (Table 3).

For the overall GALM program, 6% (standard deviation = 5) of monitored heart rate time could be classified as light, 33% (standard deviation = 13) as moderate, and 61% (standard deviation = 16) as hard. The korfball session had the highest mean percentage (88%, standard deviation = 16) of time spent in the "hard" category. The badminton session showed the highest mean percentage (21%, standard deviation = 30) of time in the "light" category.

Table 2 Main Characteristics of the Study Sample by Sex and for the Total Sample

	Men (*n* = 46)		Women (*n* = 51)		Total (*N* = 97)	
Main characteristics	Mean	SD	Mean	SD	Mean	SD
Age (y)	61.0	3.9	59.4	3.5	60.1	3.7
Weight (kg)	83.9	11.6	74.4	10.7	78.9	12.1
Height (cm)	176	5.8	165	5.6	171	7.8
BMI (kg/m^2)	27.0	3.6	27.3	4.2	27.2	3.9
Body fat (%)	25.6	4.9	38.1	5.7	32.1	8.2

Note. SD, standard deviation; BMI, body mass index.

Discussion

This article describes the background and results of a study to evaluate the intensity of GALM, a versatile physical activity program that is primarily based on a play theory and insights of social cognitive theory.

The mean age of the participants (60.1 y, standard deviation = 3.7) and the proportion of men (47%) and women (53%) in this study demonstrated that the study sample was a reasonably representative cross section of the GALM participants in general.[8] Furthermore, for purposes of representativeness, 5 different GALM groups with 5 different GALM instructors were monitored to assess the intensity of the GALM program. In this way, our measures were not unduly influenced by the personal teaching style of an individual instructor. A disadvantage of having monitored sessions led by 5 different instructors was the standardization of the GALM program, which could limit the generalizability of the study results. To minimize this variability between GALM sessions and instructors, the described structure and leisure-time sport activity scheme (Table 1) had to be adhered to strictly, and all instructors completed a 3-d GALM training course. The main characteristics of the subjects, together with the standardization procedures used, increased the likelihood of our results providing a realistic indication of the intensity of the GALM physical activity program despite our study group being only a small sample of all Dutch GALM participants.

In our study, 17 heart rate files (15%) were excluded from analysis because of abnormalities in or missing heart rate data. In one of the few studies that report on failures in heart rate assessment in a field setting, Treiber et al.[25] reported that less than 1.2% of the registrations with the Sport heart rate tester were lost because of malfunction. In that study, children were engaged in six 3-min activities: standing, walking, jogging, throwing, batting, and playing on a jungle gym. Electrode detachments resulting from sweating and body movement were cited as reasons for malfunction. A possible explanation for the higher percentage of nonrepairable heart rate files in our study could be the fact that we monitored older people, who are generally more obese than younger people and could have disturbed the transmission

Table 3 Recreational Sports Activity, Mean Heart Rate, Mean Percentage of Predicted HR_{max}, and Percentages of Monitored Heart Rate Time Classified According to the Categories Light (≤ 54% of HR_{max}), Moderate (55 to 65% of HR_{max}) and Hard (≥ 70% of HR_{max}) (ACSM, 1998a) per GALM Session and for the Overall GALM Program

	Recreational sports activity	Heart rate monitoring					n
		Mean HR (SD)	% HR_{max} (SD)	Light (SD)	Moderate (SD)	Hard (SD)	
1	Introductory/ ball game	114.3 (11.9)	71.5 (7.4)	10 (11)	36 (34)	54 (42)	4
2	Softball	120.3 (8.7)	75.2 (5.4)	1 (1)	36 (33)	63 (34)	4
3	Dance	128.0 (9.4)	80.0 (5.9)	1 (1)	17 (17)	82 (17)	5
4	Volleyball	121.5 (8.7)	76.0 (5.4)	1 (2)	30 (33)	69 (34)	9
5	Self-defense	118.9 (9.0)	74.4 (5.6)	4 (5)	38 (31)	58 (34)	8
6	Badminton	104.0 (10.5)	65.0 (6.6)	21 (30)	40 (26)	39 (36)	8
7	Basketball	121.6 (10.2)	76.1 (6.4)	5 (10)	22 (21)	73 (30)	6
8	Swimming	111.6 (8.2)	69.8 (5.1)	6 (12)	47 (25)	47 (32)	6
9	Soccer	119.6 (13.2)	74.8 (8.2)	3 (2)	31 (15)	66 (17)	9
10	Indoor hockey	116.0 (10.5)	72.5 (6.6)	7 (8)	37 (28)	56 (34)	8
11	Games circuit	126.6 (9.6)	79.2 (6.0)	2 (1)	20 (19)	78 (20)	9
12	Fitness	103.3 (8.3)	64.6 (5.2)	8 (9)	66 (12)	26 (16)	4
13	Tennis	116.0 (11.8)	72.5 (7.4)	6 (4)	36 (21)	59 (25)	5
14	Korfball	132.9 (11.8)	83.1 (7.4)	1 (1)	11 (15)	88 (16)	8
15	Athletics	112.3 (9.2)	70.2 (5.8)	12 (15)	34 (16)	54 (28)	4
Overall		117.8 (8.2)	73.7 (5.1)	6 (5)	33 (13)	61 (16)	

Note. SD, standard deviation; mean HR, mean heart rate; % HR_{max}, percentage of predicted heart rate maximum.

of heart rate signals because of subcutaneous fat. Secondly, we monitored for longer periods of time (54 to 60 min per session). Finally, the activities conducted in our study showed a much greater variety of bodily movement, which in turn could increase the risk of unintentional detachment of the transmitters attached to the participants' chests. The highest percentages of nonrepairable files were reported during the fitness lesson, the introductory/ball game, and the dance lesson.

The overall mean intensity of the GALM program was 73.7% (standard deviation = 5.1) of HR_{max} with a variation between 64.6% (standard deviation = 5.2) and 83.1% (standard deviation = 7.4) of the HR_{max}. From the relationship found between HR_{max} and $\%VO_{2max}$ it can be concluded that the overall mean intensity of the GALM program was about 60% of VO_{2max} or heart rate reserve with a variation between 50% and about 72% of VO_{2max}.[31,32] In the present study, however, the age-predicted HR_{max} equation, $HR_{max} = 220 - \text{age (in y)}$, was used as the basis for describing the intensity of the GALM program. Tanaka, Monahan, and Seals[33] argue that this equation was never validated in studies that included sufficient numbers of older adults. They conclude that the traditionally used equation underestimates HR_{max} in older adults, and that this would cause an underestimation of the appropriate intensity of prescribed exercise programs. Robergs and Landwehr[34] also emphasize that currently there is no acceptable method to estimate HR_{max} and that there is no scientific merit to using the 220 – age formula. If HR_{max} needs to be estimated, however, the most accurate equation is that of Inbar et al.[35] $HR_{max} = 205.8 - 0.685 * \text{age}$ ($Sxy = 6.4$ beats/min). In the context of the debate on the 220 – age formula, we conclude that the intensity of the GALM physical activity program is probably overestimated in this study. With this in mind, we still conclude that the overall mean intensity of the GALM program could be best classified as moderately intense (55 to 69% of HR_{max}).

The classification of the heart rate data into light, moderate, and hard intensity was based on the ACSM 1998 guidelines for developing and maintaining cardiorespiratory fitness in healthy adults.[12] The results show that, most of the time, participants were physically active in the moderate (33%, standard deviation = 13) or hard (61%, standard deviation = 16) intensity zone. Still, considerable standard deviations are reported, indicating major interpersonal differences from which it can be concluded that the intensity of the sessions varied greatly between individuals. Another consideration is the small number of participants that were measured per session ranging from 4 to 9. This variability together with the number of cases per session makes it difficult to draw hard conclusions on the intensity of the program as assessed in this study. Although the results appear promising with respect to the intensity of the GALM program, more and better-controlled studies should be conducted to gather more information on the intensity of versatile physical activity programs like GALM.

A disadvantage of our study was that the measurements took place in a time period of 6 months. This meant that GALM participants who were monitored during the first sessions of the GALM program could indeed be considered sedentary or underactive. By contrast, the participants measured in the last GALM sessions had already been physically active in the GALM program for several months. One could argue that this could have led to an underestimation of the assessed intensity results of the latter GALM sessions as a consequence of a probable heart rate-lowering training response. The lowering of heart rate during submaximal exercise, however, was only reported as an effect of prolonged participation in aerobic exercise training.[9,19] Therefore, we think the difference in the amount of GALM sessions participated in at the time of heart rate monitoring did not affect the study results.

In sum, this study provides information on the background and structure of the GALM program. The results of the intensity study are an indication that an attractive and versatile physical activity program like GALM is able to meet the intensity criteria as set by the ACSM. In the context of health promotion this can be considered as an encouragement, given the fact that programs offering different physical activity options might be particularly appealing to older adults.[14,15]

Acknowledgments

This research was made possible by a grant from Zorg Onderzoek Nederland, grant 2200.0074.

References

1. Backx FJG, Swinkels H, Bol E. How physically (in)active are Dutch adults in their leisure-time? (Eng. trans). *CBS maandschrift*. 1994;3:4-11.
2. Powell KE, Blair SN. Public health burdens of sedentary living habits: theoretical but realistic estimates. *Med Sci Sports Exerc*. 1994;26(7):851-856.
3. Urlings IJM, Douwes M, Hildebrandt VH, Stiggelbout M, Ooijendijk WTM. Relative validity of a physical activity questionnaire regarding the 'activity guidelines' (Eng. trans). *Geneeskunde en Sport*. 2000;33:17-22.
4. Shephard RJ. What is the optimal type of physical activity to enhance health? *Br J Sports Med*. 1997;31:277-284.
5. King AC, Rejewski WJ, Buchner DM. Physical activity interventions targeting older adults: a critical review and recommendations. *Am J Prev Med*. 1998;15(4):316-333.
6. Van der Bij AK, Laurant MGH, Wensing M. Effectiveness of physical activity interventions for older adults: a review. *Am J Prev Med*. 2002;22(2):120-133.
7. Stevens M, Bult P, de Greef MHG, Lemmink KAPM, Rispens P. Groningen Active Living Model (GALM): stimulating physical activity in sedentary older adults. *Prev Med*. 1999;29:267-276.
8. Stevens M, Lemmink KAPM, de Greef MHG, Rispens P. Groningen Active Living Model (GALM): stimulating physical activity in sedentary older adults; first results. *Prev Med*. 2000;31:547-553.
9. Dept of Health and Human Services. Physical Activity and Health: a report of the Surgeon General. Atlanta, GA: US Dept of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996:11-80.
10. Stewart AL, Verboncoeur CJ, McLellan BY, Gillis DE, Rush S, Mills KM, et al. Physical activity outcomes of CHAMPS II: a physical activity program for older adults. *J Gerontol A Biol Sci Med Sci*. 2001;56A(8):465-470.

11. De Jong J, Leibbrand K, Stevens M, de Greef MHG, Lemmink KAPM. *The effects of the GALM program on physical activity and other lifestyle characteristics, fitness, health and daily functioning of sedentary and underactive older adults* (Eng. trans.). Groningen, The Netherlands:University of Groningen, 2004:49-67.
12. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc*. 1998a;30(6):975-991.
13. *Physical activity, fitness and health: international proceedings and consensus statement*. Champaign, IL: Human Kinetics, 1994:993-1005.
14. Ecclestone NA, Myers AM, Paterson DH. Tracking older participants of twelve physical activity classes over a three year period. *J Aging Phys Activity*. 1998;6:70-82.
15. King AC. Interventions to promote physical activity by older adults. *J Gerontol A Biol Sci Med Sci*. 2001;56A(2):36-46.
16. Dishman RK, Buckworth J. Increasing physical activity: a quantitative synthesis. *Med Sci Sports Exerc*. 1996;28(6):706-719.
17. Bult P, Rispens P. *Learning to move: acquiring versatility in movement through upbringing and education*. Maastricht, The Netherlands: Shaker Publishing B.V., 1999:29-42.
18. Bandura A. *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice Hall, 1986:399-409.
19. American College of Sports Medicine Position Stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 1998b;30(6):992-1008.
20. Hurley BF, Hagberg JM. Optimizing health in older persons: aerobic or strength training. *Exerc Sport Sci Rev*. 1998;26:61-89.
21. De Jong J, Stevens M, de Greef MHG, Dirks CJ, Haitsma J, Lemmink KAPM, et al. GALM questionnaire to select sedentary seniors: reliability and validity. *Med Sci Sports Exerc*. 1999;31(5):S379.
22. Nuñez C, Gallagher D, Visser M, Pi-Sunyer FX, Wang Z, Heymsfield SB. Bioimpedance analysis: evaluation of leg-to-leg system based on pressure contact foot-pad electrodes. *Med Sci Sports Exerc*. 1997;29(4):524-531.
23. Washburn RA, Montoye HJ. Validity of heart rate as a measure of mean daily energy expenditure. *Exerc Physiol*. 1986;2:161-172.
24. Leger L, Thivierge M. Heart rate monitors: validity, stability, and functionality. *Physiol Sports Med*. 1988;16:143-151.
25. Treiber FA, Musante L, Hartdagan S, Davis H, Levy M, Strong WB. Validation of a heart rate monitor with children in laboratory and field setting. *Med Sci Sports Exerc*. 1989;21(3):338-342.
26. Eston RGA, Rowlands V, Ingledew DK. Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *J Appl Physiol*. 1998;84: 362-371.
27. Goldsmith R, Miller DS, Mumford R, Stock MJ. The use of energy: long-term measurements of heart rate to assess energy expenditure. *J Physiol*. 1967;189.
28. Strath SJ, Swartz AM, Bassett DR, O'Brien WL, King GA, Ainsworth BE. Evaluation of heart rate as a method for assessing moderate intensity physical activity. *Med Sci Sports Exerc*. 2000;32(9):S465-S470.
29. Washburn RA, Montoye HJ. Reliability of the heart rate response to submaximal upper and lower body exercise. *Res Q Exerc Sports*. 1985;56(2):166-169.

30. Wasserman K, Hansen JE, Sue DY, Whipp BJ, Casaburi R. *Principles of exercise testing and interpretation*. Philadelphia: Williams & Wilkins, 1994:112-131.
31. Londeree BR, Ames SA. Trend analysis of the percent $VO_{2\ max}$-HR regression. *Med Sci Sports Exerc*. 1976;8(2):123-125.
32. Swain DP, Abernathy KS, Smith CS, Lee SJ, Bunn SA. Target heart rates for the development of cardiorespiratory fitness. *Med Sci Sports Exerc*. 1994;26(1):112-116.
33. Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. *J Am Coll Cardiol*. 2001;37(1):153-156.
34. Robergs RA, Landwehr R. The surprising history of the HR_{max} = 220-age equation. *J Exerc Physiol* online 2002;5(2):1-10.
35. Inbar O, Oten A, Scheinowitz M, Rotstein A, Dlin R, Casburi R. Normal cardiopulmonary responses during incremental exercise in 20-70-yr-old men. *Med Sci Sports Exerc*. 1994;26(5):538-546.