Consensus Physical Activity Guidelines for Asian Indians

Misra A, Nigam P, Hills AP, Chadha DS, Sharma V, Deepak KK, Vikram NK, Joshi S, Chauchan A, Khanna K, Sharma R, Mittal K, Passi SJ, Seth V, Puri S, Devi R, Dubey AP, and Gupta S for Physical Activity Consensus Group (See Annexure 1)

Running Title: Physical Activity Guidelines for Asian Indians

Corresponding Author:

Anoop Misra,
Director and Head, Department of Diabetes and Metabolic Diseases, Fortis Flt. Lt. Rajan Dhall Hospital, Vasant Kunj, New Delhi 110070, India.
Director, National Foundation for Diabetes, Obesity, and Cholesterol Disorders (N-DOC), New Delhi, India, and
Director, Diabetes and Metabolic Diseases, Diabetes Foundation (India), New Delhi, India
Ph: 91-11-4277-6222 (Ext: 5030); Fax: 91-11-4277-6221
Email: anoopmisra@metabolicresearchindia.com

Background

According to current WHO estimates, non-communicable diseases (NCDs) represent 43% of disease burden globally and this figure is expected to rise to be responsible for 60% of the disease burden and 73% of all deaths by 2020. In 1990, nearly 40% of deaths were attributable to NCDs and it has been projected that this will increase to 66% in 2020 [1]. India is currently undergoing rapid economic and demographic transformations. A key feature of these transformations has been the change in the nature of the Indian diets and lifestyle. Scientific studies from various parts of India have reported the rising prevalence of lifestyle-related diseases such as type 2 diabetes mellitus (T2DM), the metabolic syndrome, hypertension, coronary heart disease (CHD) etc., frequently in association with overweight or obesity [2, 3].

Comparative data show that Asian Indians are more sedentary than white Caucasians [4]. Findings from the Newcastle Heart Project (NHP) [comprising South Asians (n=105) and Europeans (n=416)] showed that South Asians are less physically active than Europeans [4]. Another study showed that lower physical activity in Asian Indians, Pakistanis or Bangladeshis than Europeans inversely correlated with body mass index (BMI), waist circumference (WC), systolic blood pressure, plasma glucose and insulin levels [5]. The prevalence of T2DM and impaired glucose tolerance has been shown to be significantly lower in higher quartiles of physical activity i.e., 16.8%, 13.2%, and 11% for sedentary, moderately heavy, and heavy workers in South India, respectively [6]. Sedentary lifestyle amongst Asian Indians is likely to contribute to the higher risk of T2DM and CVD [7, 8].

The health benefits of physical activity are well established [9]. Positive outcomes of moderate-intensity physical activity include an increase in high-density lipoprotein cholesterol, reduction of blood pressure, long-term maintenance of weight loss and decrease in the risk of death from lifestyle-related diseases [9]. These benefits are most noticeable in sedentary individuals who introduce regular physical activity into their lifestyle. Lifestyle intervention studies have shown prevention of T2DM and CHD with appropriate physical activity and diet. In the Diabetes Prevention Program Outcomes Study (DPPOS), an extension study of the Diabetes Prevention Program, the incidence of diabetes was compared in prediabetic individuals among three groups: lifestyle (n=910), metformin (n=924), and placebo (n=932) after 10 years of intervention. The results showed modest weight loss and prevention or delay of diabetes in the lifestyle modification group [7, 8]. However, no physical activity guidelines have been proposed for Asian Indians who are predisposed to develop T2DM and CHD. At the same time, it should be noted that there is a paucity of studies regarding physical activity in Asian Indians. Nevertheless, physicians, nutritionists and exercise therapists need to have physical activity guidelines not only for healthy adults but also for children, pregnant women, and those suffering from T2DM and CHD, etc.

International guidelines regarding physical activity have been mostly derived from studies done on white Caucasians [10]. The most well known evidence-based physical activity recommendations for public health were first issued by the American Heart Association (AHA), the American College of Sports Medicine [11, 12] and the US Department of Health and Human Services (USDHHS) [10]. For healthy adults, 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity is recommended [10]. Although the US guidelines

include a toolkit for “building awareness and participation” in communities, they do not explicitly cover “putting the guidelines into practice”.

Objectives and Process of Consensus Development:

This consensus statement was prepared by more than 102 renowned experts from all over India, and nearly 27 experts from the USA, UK and Australia, to achieve balance in the areas of diabetes, exercise physiology, nutrition, internal medicine, metabolic diseases, endocrinology, cardiology, and sports medicine.

In this consensus statement, we have derived data from studies on physical activity globally, and those undertaken on Asian Indians residing in India and elsewhere. Selected steering committee experts summarized relevant data from the national and international scientific literature. The literature search was undertaken using the keywords “Physical activity and Asian Indians or Physical activity recommendations for Asian Indians, or Physical activity and non-communicable diseases” from the medical search engine PubMed (National Library of Medicine, Bethesda, MD, USA) from 1966 to October 2010. Manual searches for other important references and physical activity guidelines in other ethnic groups were also completed. When no data were available for Asian Indians, available International guidelines were adapted with the Indian perspective in mind.

Steering committee experts (Annexure-1) prepared the first draft of consensus statements for each topic area. Draft guidelines for each topic were circulated to all selected experts for feedback and comment before the meeting. The final draft was modified and subsequently circulated again to all experts for comments and then finalized for publication.

Definitions of Physical Activity Intensity Levels

1. Low-intensity physical activity elicits a slight increase in breathing rate and is relative to a given person (e.g., strolling <3 km/h on level firm ground, tidying the house, leisurely stationary cycling <50 W, cooking).

2. Moderate-intensity physical activity elicits a moderate, noticeable increase in depth and rate of breathing, while still allowing comfortable talking and is relative for a given person (e.g., purposeful walking 3–6 km/h on level firm ground, water aerobics, cycling for pleasure <16 km/h, cleaning the house, hiking, gardening, etc).

3. *Vigorous-intensity physical activity* elicits a noticeable increase in depth and rate of breathing, will not be able to allow more than a few words without pausing for a breath (e.g. walking a kilometer in less than 10 minutes, jogging, cycling, and aerobic dancing, and jumping rope).

Safety Concerns in Exercise:

1. Choose an appropriate type of physical activity according to the fitness level and health goals of each individual.
2. Increase physical activity gradually over time whenever more activity is necessary to meet guidelines or health goals.
3. Protect by using appropriate gear and sports equipment, look for safe environments, follow rules and policies, and making sensible choices about when, where, and how to be active.
4. Supervision of a health-care provider is required before initiating exercise if an individual has chronic conditions or symptoms.
5. Adequate hydration prior to physical activity is recommended (e.g., 17 ounces of fluid consumed 2 h before physical activity). During physical activity, fluid should be taken early and frequently in an amount sufficient to compensate for losses in sweat reflected in body weight loss, or the maximal amount of fluid tolerated.

Physical Activity Guidelines for Healthy Adults

These guidelines are adapted and modified from a previously published consensus guidelines statement [13]:

1. Physical inactivity should be avoided as far as possible.
2. Pre-participation medical consultation is recommended for those with chronic diseases, particularly cardiovascular disease (CVD), those who are symptomatic and those who are sedentary.
3. In general, a total of 60 min of physical activity is recommended every day which this includes aerobic activity, work-related activity and muscle-strengthening activity.
4. This should include at least 30 min of moderate-intensity aerobic activity (e.g., brisk walking, jogging, hiking, gardening, bicycling etc.), 15 min of work-related activity (e.g., carrying heavy loads, climbing stairs etc.) and 15 min of muscle-strengthening exercises (Annexure-2). The latter should be done at least 3-4 times a week using light weights.
5. Aerobic activity should be performed in bouts of at least 10 minutes duration.
6. For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 min per week, or engage in 150 min of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.
7. Brisk walking (walking at an intensity wherein an individual finds speaking difficult but not impossible) is the preferred initial mode of exercise as this does not require any special training or equipment.
8. Inactive people should start slow and gradually increase physical activity.
9. The total duration of physical activity could also be accumulated in small 10-15 min periods of physical activity 2-3 times a day.
10. Physically intensive Yoga exercises should be encouraged but more research is required in this area.

Summary Recommendations for Healthy Adults:

Recommended physical activity guidelines for adults should be 60 min every day. It should include at least 30 min of moderate-intensity aerobic activity, 15 min of work-related activity and 15 min of muscle strengthening exercises. Gradual increase in physical activity is recommended for inactive people.

Children and Adolescents

Background and Evidence

Regular physical activity during a person's formative years (childhood and adolescence) is widely acknowledged as essential for healthy growth and development [14, 15]. Despite assessment difficulties, evidence suggests that many children and adolescents are less active than is recommended. The evidence suggests that obese youngsters are less physically active than those with a healthy body composition [16, 17] and spend more time in sedentary activities, such as watching television and using other electronic media [17-19]. Potential outcomes of reduced activity levels are suboptimal development of motor skills and a lack of motivation to participate wholeheartedly in physical activity [20]. There is also some evidence that physical activity levels decline from childhood through the adolescent years [21].

Most of the studies to date relate to aerobic physical activity, while resistance training is considered to be unsafe and potentially injurious to the growth and development of children and adolescents [22]. However, evidence related to the safety and efficacy of resistance exercise for this subgroup has increased over recent years [22]. Risk of injury in relation to resistance training is largely associated with inadequate professional supervision encompassing poor exercise prescription rather than the activity *per se*.

Available Guidelines [10]:

1. Children and youth aged 5–17 y should accumulate at least 60 min of moderate- to vigorous-intensity physical activity daily.
2. Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.
3. A minimum of 60 min or more of moderate-intensity physical activity on a daily basis would achieve the health benefits associated with physical activity. Preferably these activities should be in the form of sports [10].
4. Some health benefits may be achieved by accumulating 30 min/day of moderate-intensity physical activity which should represent the starting volume for children who are currently sedentary [10].
5. Most health outcomes, in particular obesity and related measures of cardio-metabolic health, respond to aerobic physical activity with greatest benefits commonly achieved at the higher end of the physical activity spectrum [23].
6. Skeletal health is improved by modest volumes of resistance training and other weight-bearing activities (e.g., jumping) performed 2-3 days/week. Vigorous weight-bearing physical activity should be incorporated or added when possible, including activities that strengthen muscle and bone [24].

7. Participation in regular physical exercise results in better cognitive development [25] and improved cardiovascular fitness [26] which also results in effective autonomic control [27, 28].
8. Screen time for leisure-time television/computer viewing should be less than 2 h a day [13].

School-Based Approach:

Schools are a key setting to focus on given the significant amount of time children spend there. A school-based multi-component model of health education including physical activity not only improved knowledge, attitudes and practice of schoolchildren in New Delhi, but also improved anthropometric and metabolic variables [29, 30].

Schools can undertake a combination of strategies and approaches to help children be more active, including:

1. Creating infrastructure (e.g., playgrounds) and policies (mandatory exercise periods) to encourage physical activity for all students;
2. Collecting valid and reliable data and using analytical tools and systems to understand student's physical activity needs and fitness levels, and promoting approaches that are effective in changing physical activity behaviors and, ultimately, health outcomes;
3. More emphasis on exercise/physical activity-related activities in the overall assessment of students;
4. Maintaining strong physical activity programs that engage students in moderate- to vigorous-intensity physical activity for at least 50% of physical activity class time;
5. Providing a variety of activities and specific skills so that students can be physically active not just during class, but throughout the day and across the school year; and
6. Providing qualified professionals who are trained in teaching methods to engage students in physical education, including for students who face greater barriers to activity.

Summary Recommendation for Asian Indian Children

General physical activity guidelines for children and adolescents should include the accumulation of a minimum of 1 h and up to several hours of at least moderate-intensity aerobic physical activity daily. Activity may mostly comprise sports activities and active transport, and be over and above habitual physical activity. Sedentary behaviour, including television viewing and working on computers, should be restricted to less than 2 h per day during leisure time.

Table-1: Exercise Prescription for Children and Adolescents

Type of exercise	Frequency	Duration
Moderate- or vigorous-intensity aerobic physical activity (such as running, hopping, skipping, jumping rope, swimming, dancing, and bicycling)	At least 3 days a week (Preferably daily), [13])	60+ min per day
Muscle-strengthening physical activity (such as playing on playground equipment, climbing trees, playing tug-of-war, lifting weights, or working with resistance bands)	At least 3 days a week	20-30 min*
Bone-strengthening physical activity (such as running, jumping rope, basketball, tennis, and hopscotch)	At least 3 days a week	20-30 min*

[10] http://www.health.gov/paguidelines/

** After comfortable completion of 10-15 repetitions of an exercise, the resistance can be increased by 10%.*

Pregnant and Lactating Women

Background and Evidence

Exercise is an important component of a healthy lifestyle during pregnancy. Despite a comprehensive understanding of the physiologic and musculoskeletal changes during pregnancy, the responses of the pregnant woman and fetus to exercise has not been well investigated [31]. In particular, very little information exists regarding exercise tolerance and adaptations to resistance training during pregnancy. Response to exercise largely depends upon the health and fitness of the woman pre- and during pregnancy. Specifically, in India, a longstanding traditional mindset is that pregnant women should not exercise.

A lower incidence of obesity and diabetes in both mother and child is seen in the most active category of women [32, 33]. A high level of fitness pre-pregnancy and regular physical activity during pregnancy can prevent excessive weight gain during this period [34]. Regular physical activity in women is associated with reduced risk of gestational diabetes and pre-eclampsia [33, 35]. The protective effect of physical activity can be explained by an enhanced placental growth and vascularity [36], by decreased oxidative stress [37], and reduced inflammation [38].

Available Guidelines

1. All decisions regarding exercise in pregnant women should be taken in consultation with treating obstetrician.
2. Exercise selection should be based on the health status of the pregnant woman and exercise goals, and should be individualised. It is important to note that some women may not be able to exercise during the third trimester of pregnancy or may only be able to manage mild exercise.
3. Traditional exercise recommendations for pregnant women have been consistent with public health guidelines for adults - moderate-intensity exercise for at least 30 min on most, if not all, days of the week (~150 min) in the absence of any contraindications. A range of aerobic exercise modalities, including walking, cycling, and swimming are recommended.
4. Healthy pregnant women who engaged in vigorous-intensity aerobic activity before pregnancy are encouraged to continue physical activity, but there is no basis for recommending vigorous aerobic exercise for inactive women.
5. Additionally, resistance training using light weights and moderate-to-high repetitions (1 to 2 sets of 12 to 15 reps) is recommended to maintain flexibility and muscle tone, and prevent lower back pain. Resistance training on machines is recommended however free weights, elastic bands and callisthenics may be substituted if exercise machines become too difficult to use due to increased size and balance problems. Women should be encouraged to practice controlled breathing while lifting and not hold their breath. Pregnant women should avoid exercising in the supine position after ~16 weeks of gestation.
6. Exercises that cause pain, discomfort or any obstetric-related symptoms should be discontinued.

Summary Recommendation for Pregnant Women

Healthy women who have uncomplicated pregnancies can maintain their previous exercise program following consultation with their doctor. There is now general consensus that it is safe to commence an exercise program during pregnancy. Despite a lack of evidence regarding a safe upper limit of exercise as pregnancy progresses, discomfort and fatigue typically cause most women to reduce their participation in exercise. Moderate-intensity exercise is considered safe throughout pregnancy. Due to a weakening of the pelvic floor muscles during pregnancy and potential damage during birth, it is important to begin conditioning the pelvic floor muscles from the start of pregnancy and continue throughout. Exercises should be recommenced as soon as practicable following the birth of the baby.

Elderly

Background and Evidence

Declines in muscular strength and endurance occur as a function of biological aging and reductions in physical activity [39]. Low levels of muscular strength, particularly in the muscles of the lower back and lower limb, can compromise mobility and increase the risk of falls in older adults [39, 40]. Ageing leads to a decline in muscle mass, increase in body fat ("sarcopenic obesity"), and redistribution of body fat thereby increasing truncal fat. These body composition changes may be more marked in Asian Indians who have a high amount of truncal adiposity and low muscle mass [2]. All these body composition changes lead to increased tendency for T2DM and atherogenic dyslipidemia [41].

There is strong evidence of the benefits of aerobic physical activity for older adults [12]. Regular aerobic physical activity has an inverse dose-response relationship with major chronic diseases (CHD, T2DM, depression, some cancers, dementia, disability, and loss of function). The recommended dose of aerobic physical activity reduces the risk of these conditions and functional limitations by 30-50%, and higher doses of physical activity provide further benefits [12].

Available Guidelines

1. Recommended doses of aerobic activity and muscle-strengthening activity for men and women over 65 years of age (and those aged 50–64 y with clinically significant chronic conditions and/or functional limitations), are similar to those for ''all healthy adults''[12].
2. Resistance training may be particularly beneficial in older adults because of the potential to reduce the age-related loss of muscle mass, sarcopenia and risk of falls [12]. Older adults should also engage in resistance exercises on 2 days/week which should involve the major muscle groups (using small weights). Major benefits of resistance training include preservation of muscle mass and prevention of age-related sarcopenia.
3. Daily activities that involve lifting, carrying, and pushing tasks should be maintained because they can also benefit muscle and bone health.

4. Greater strength and muscle power assist in the maintenance of function and prevention of disability, including a lower risk of falling. Balance training, along with activities to strengthen the muscles of the legs, is the best strategy to reduce falls and complications from falls.
5. In sedentary individuals, gradual escalation of physical activity is recommended, after pre-activity medical evaluation especially in those with chronic diseases, particularly CHD. All decisions regarding the initiation of exercise programs for the elderly should be taken in consultation with a physician.
6. Sudden starts or accelerations in physical activity, or any high-intensity exercises should be avoided.

Summary Recommendation for Elderly

Recommended doses of aerobic activity and muscle-strengthening activity for men and women over 65 years of age (and those aged 50–64 y with clinically significant chronic conditions and/or functional limitations), are similar to those for all healthy adults. Resistance training is acknowledged as an effective intervention for improving strength and physical functioning in older adults.

Physical Activity Guidelines for Non-communicable Diseases

Cardiovascular Diseases and Hypertension

Background and Evidence

Cardiovascular disease (CVD) is the leading cause of death in India, and its contribution to mortality is rising; deaths due to CVD are expected to double from 1985–2015 [42]. Regular physical activity reduces the risk of obesity, blood lipid abnormalities, hypertension, and T2DM, and has been shown to reduce the risk of CHD substantially [43-46]. Despite this, more than half of the Indian population, including those with CVD, are physically inactive [47]. The benefits of cardiac rehabilitation have been established beyond doubt however it is still being under-utilized. Only some 25-30% of men and 11-20% of women eligible for cardiac rehabilitation participate in such programs [45].

Design and Administration of the Exercise Training Program

Program structure

Cardiac rehabilitation programs are generally recommended for patients with established CHD and heart failure. Physician endorsement of cardiac rehabilitation is one of the most important predictors of participation. One of the most effective ways to combat the lack of referral is to include cardiac rehabilitation in standardized order sets for appropriate cardiac patients. The program is divided into three or four phases on the basis of the patient's clinical status (Table 2). Patients with hypertension or other modifiable CHD risk factors can start unsupervised physical activity after a recommended pre-activity evaluation.

Supervised *vs.* Unsupervised Physical Activity

1. Patients who have advanced CHD and those who lack confidence will benefit most from up to 12 weeks of supervised exercise rehabilitation that incorporates endurance and resistance activity. Supervision may be beneficial to reduce anxiety, monitor symptoms and arrhythmias, and establish appropriate physical activity intensity after an acute cardiovascular event or vessel revascularization.
2. Patients in unsupervised programs should generally be encouraged to exercise to the onset of mild dyspnea for the reasons mentioned earlier. Patients exercising on their own can also be encouraged to judge their exercise intensity using the “talk test” (i.e., exercising at the fastest walking rate that still permits comfortable conversation).
3. High-intensity exercise, sudden start of exercise, and exercise in extreme weather conditions should be avoided.

Pre-activity Evaluation

1. All decisions regarding the initiation of exercise programs in the elderly should be taken in consultation with a physician/cardiologist. All patients with CHD must undergo a pre-activity evaluation.
2. Those with established CHD should undergo a symptom-limited exercise test before entering a training program. The exercise test is required to exclude important symptoms, ischemia, or arrhythmias that might require other interventions before exercise training. The exercise test also serves to establish baseline exercise capacity, optimal $VO_{2\ max}$ and to determine maximum heart rate for use in preparing an exercise prescription. These tests are usually done with the patient on his or her usual medications to mimic the heart rate response likely to occur during exercise training.

Physical Activity Session

1. Most patients with hypertension and other modifiable risk factors for atherosclerosis should aim to commence with 30 min of moderate-intensity activity on most, preferably all, days of the week.
2. Those enrolled in a cardiac rehabilitation program should begin with a 5 min general warm-up followed by at least 20 min of aerobic exercise training and 5-15 min of cool-down.
3. The aerobic exercise training component is generally performed at 60-70% of $VO_{2\ max}$ which corresponds to approximately 70-80% of maximum heart rate (Table 3).
4. Patients who did not undergo exercise testing before the program can exercise at a heart rate 20 beats higher than their normal resting value.
5. Some patients, especially those with left ventricular dysfunction, require lower training intensities. Such patients can exercise to the point of mild dyspnea and maintain that level during the training session. Although 20 min of exercise training is standard, shorter periods of exercise training are beneficial and longer sessions almost certainly provide additional benefit.

Summary Recommendations for Patients with CHD and Hypertension

Usually 210 min per week of moderate-intensity physical activity should be the aim. However, for the latter, depending upon the clinical condition, low-intensity, individualised and supervised exercise program could be devised.

Table 2: Phases of Cardiac Rehabilitation by Physical Activity

Phase 1
Inpatient rehabilitation directed by physical therapy departments or a dedicated cardiac rehabilitation staff which emphasizes a gradual, progressive approach to exercise and an education program that helps the patient understand the disease process.
Phase 2
Phase 2 refers to physician-supervised outpatient programs. Emphasizes safe physical activity to improve conditioning with continued behaviour modification aimed at smoking cessation, weight loss, healthy eating, and other factors to reduce disease risk. This multi-faceted outpatient rehabilitation should last 2-3 months.
Phase 3
Supervised rehabilitation, lasting 6-12 months establishes a prescription for safe exercise that can be performed at home and continues to emphasize risk factor reduction.
Phase 4
Phase 4 refers to programs that do not usually provide medical supervision and are usually provided by health clubs and fitness facilities. It is a maintenance program and needs to be carried on for an indefinite period.

Table 3 - Exercise Prescription for Patients with Coronary Artery Disease

Patients	Intensity	Frequency	Duration
Aerobic exercise			
General CAD	70-85% peak HR	≥3 times weekly	≥20 min per session
With asymptomatic ischemia	70-85% ischemic HR	≥3 times weekly	≥20 min per session
With angina	70-85% ischemic HR or angina onset	≥3 times weekly	≥20 min per session
With claudication	Walking to pain tolerance	≥3 times weekly	≥30 min per session
With New York Heart Association Class I-III HF	Walking till onset of dyspnea	≥3 times weekly	As per effort tolerance
Hypertension	Moderate-intensity	≥3 times weekly	≥30 min per session
Resistance exercise			
For most patients with cardiovascular disease	30-50% of the 1-RM*	2-3 times weekly	1 set of exercise consisting of 12-15 repetitions per each muscle group **

[46]* 1-RM = *maximal weight the individual can lift for 1 exercise*

HF = heart failure; HR = heart rate; ** Muscle group - chest press, shoulder press, triceps extension, biceps curl, pull-down (upper back), lower-back extension, abdominal crunch/curl-up, quadriceps extension or leg press, leg curls (hamstrings), calf raise

Prediabetes and Diabetes

Background and Evidence

Incidence and prevalence of T2DM are increasing globally. The prevalence of diabetes between 20-79 years of age is projected to be 7.1% in India in 2010 (total population with diabetes 50.7 million) and these figures are estimated to rise to 8.6% by 2030 (87.0 million) [48]. The increasing trend of diabetes in Asian Indians living in India is more apparent in urban populations (exponential trend $R^2 = 0.744$) than rural populations ($R^2 = 0.289$) [49].

Evidence from the DPPOS, and other prevention trials conducted in patients with prediabetes shows that appropriate lifestyle modification including physical activity could lead to risk reduction in incidence of T2DM by almost 58% [7]. Studies have shown that resistance and aerobic exercise is effective in improving metabolic profile of adults with T2DM [50]. Previous research has reported improved insulin sensitivity/resistance and reductions in hyperglycemia-related medications as a result of exercise training [51, 52]. In particular, supervised resistance training (max 10 repetitions for >3 days per week) has been shown to lead to significant improvement in insulin sensitivity and values of glycosylated haemoglobin, lipid profile and truncal and peripheral subcutaneous adipose tissue in Asian Indians with T2DM [50].

It has been reported that children and adolescents with type 1 diabetes should complete a minimum of 30–60 min of moderate-intensity physical activity daily [53]. Additional physical activity beyond 60 min/day would be helpful in maintaining glycemic profile for T2DM patients [50].

Cautions

1. All decisions regarding the initiation of exercise programs for patients with diabetes should be taken in consultation with a physician/diabetologist. Ideally, all patients should undergo a pre-activity evaluation.
2. Sudden commencement or an acceleration in physical activity dose, or any high-intensity exercises should be avoided.
3. It is best to avoid exercise if:
    a. Blood glucose level is >300 mg/dl.
    b. Low blood glucose (hypoglycemia) <70 mg/dl.
    c. In type 1 diabetes, fasting glucose level is >250 mg/dl and ketosis is present.
    d. In the presence of proliferative or severe non-proliferative diabetic retinopathy, vigorous aerobic or resistance exercise may be contraindicated because of the potential risk of triggering vitreous haemorrhage or retinal detachment.
    e. In the presence of severe peripheral neuropathy, it may be best to encourage non-weight-bearing activities such as swimming, bicycling, or arm exercises.

Summary Recommendations for Patients of Diabetes:

Daily physical activity of 60 min duration including 10-15 min of resistance exercise and work-related activity should be maintained for all days of the week as has been recommended for healthy people previously.

Obesity

Background and Evidence

Many urban and semi-urban Asian Indians are becoming increasingly sedentary because of mechanisation and increasing use of television and computer [2]. Environmental factors such as psychological and social behaviour and lack of facilities such as gyms and playgrounds, plus safety issues are also contributing to physical inactivity in urban areas. Obesity is increasingly seen in adults [2] and children [54]. Mostly, Asian Indians have abdominal obesity [55], which dysregulates glucose insulin metabolism and predisposes to the metabolic syndrome and dysglycemia [55].

Obesity prevention in adults can potentially have a major impact in reducing morbidity and mortality that result from the chronic effects of excess body fatness [2].Commonly available guidelines support physical activity and behaviour therapy as a part of weight management. Public policies are required to create environments that can assist all populations to achieve and sustain healthful lifestyle behaviours.

Available Evidence/Guidelines:

.

1. Some observational data indicate that individuals performing at least 45–60 min of activity on most days gain less weight than less active men.
2. At least the equivalent of 150 minutes/week of moderate-intensity aerobic physical activity for substantial health benefits and 300 minutes/ week of moderate-intensity physical activity for more extensive health benefits [10].
3. To prevent weight regain after weight loss, 60-90 min of daily moderate-intensity physical activity is recommended [56].

Summary Recommendations for Patients with Obesity:

Gradual initiation and increase in duration of physical activity among sedentary individuals is recommended. Aerobic exercise is of the greatest value for individuals who are obese. The ultimate minimum goal should be to achieve 60 min of continuous moderate-intensity aerobic exercise 7 times per week. Once an individual loses weight, a maintenance phase with the same duration, intensity, and frequency of exercise should be continued for an indefinite period [23].

Table 4 - Guidelines for Physical activity for Overweight and Obesity [23]

Intensity	Duration	Frequency
Moderate-intensity aerobic exercise	60 min	Daily

Vigorous-intensity exercise	60 min	3 or more days per week

Table 5 - Phases of Weight Management

Phase 1
Screening for cardiovascular and respiratory adequacy. Any clinically significant anomalies found require full evaluation by appropriate specialist physicians, and only after these issues are adequately managed and stabilized should an active exercise program begin.
Phase 2
Behavioural change treatment would be required with a trained professional having an in-depth discussion with the patient regarding the changes required. The main strategies employed in behavioural therapy for weight control are self-monitoring, stimulus control, problem solving, contingency management, cognitive restructuring and social support.
Phase 3
Phase 3 refers to a physician-supervised reasonable goal for weight loss. Weight-loss goals for each patient must be individualized and cannot be unilaterally based on standard weight-for-height norms.
Phase 4
Maintenance phase continued for an indefinite period.

Policy Issues (National/state):

1. Mass awareness program regarding health benefits of physical activity**.**
2. Encouragement of community fitness programs like health walks should be encouraged.
3. Periodic monitoring of nutritional and obesity status of children and adults by a National Monitoring Team.
4. Establishment of fitness rooms, gyms, playgrounds and walking and bicycling tracks.
5. Encouragement of physical activity at the workplace.
6. School-based programs should be based on the importance of healthy lifestyle and increase in physical activity. It should be mandatory for each school to employ qualified school professionals who are trained in teaching methods to engage students in physical education, including students who face greater barriers to activity. In India, we have initiated a comprehensive program aimed at childhood obesity, “MARG” (Hindi for “The Path”) [30]. Children are given nutritional and physical activity education through lectures and leaflets, and with the help of debates, skits, and drama related to health topics. Parents and children also take part in making healthy recipes. These comprehensive programs initiated on a large scale for the first time in South Asia aim to cover 5, 00,000 children in 15 cities of North India. Further, we aim to impart education regarding diet and physical activity not only to children, but also to teachers and

parents. The MARG program is the first large scale community intervention project in South Asia which focuses 100% on primary prevention of not only diabetes, but on non-communicable diseases in general.

Research Issues for India:

1. Epidemiological studies on the level of physical activity and various disease states are required
2. More research is needed to determine the optimal dose of aerobic and muscle strengthening exercise in for prevention of obesity and diabetes and other NCDs.
3. Intervention studies with different types and duration of physical activity and its effect on cardiovascular risk factors.
4. Effect of duration and intensity of physical activity like classical dancing, playing cricket etc., on physical fitness.
5. Studies on effect of yoga on metabolism and intervention with Yogic exercises.

ANNEXURE-2:

Protocol for strengthening exercise:

- Individuals should complete a 10 min warm-up of gentle stretching exercise of the upper and lower limb to prevent any muscle damage and reduce soreness.
- First, the one-repetition maximum (1RM) needs to be calculated for each muscle group (e.g., biceps, shoulders, hip, calf etc).
- 1RM is the maximum number of repetitions performed before fatigue prohibits the completion of additional set of repetition. Consequently, the load that produces fatigue on the third repetition is termed a three repetition maximum (3 RM).
- A 3RM for each muscle group should be identified and the individual commences activity on one weight less than the 3RM.
- The individual should perform 10 repetitions using that weight and 2 sets in each muscle group. If the individual is able to perform this prescription at the end of the week, 0.5 kg can be added in the following week.
- The exercise protocol should be terminated in case of any unusual chest pain or shortness of breath.

ANNEXURE-3:

Description of the activity	METs*
Sleeping	0.9
Meditating	1
Riding in a bus	1
Sitting - reading, book, newspaper, etc.	1.3
Watering lawn or garden, standing or walking	1.5
Typing, electric, manual, or computer	1.5
Eating (sitting)	1.5
Sitting - meeting, general, and/or with talking involved	1.5
Sitting - studying, general, including reading and/or writing	1.8
Standing - reading	1.8
Standing - talking or talking on the phone	1.8
Walk/stand combination for religious purposes, usher	2
Talking and eating or eating only (standing)	2
Walking, less than 2.0 mph, level ground, strolling, very slow	2
Food shopping with or without a grocery cart, standing or walking	2.3
Ironing	2.3
Stretching, hatha yoga	2.5
Tailoring, machine sewing	2.5
Motor scooter, motorcycle	2.5
Walking, 2.0 mph, level, slow pace, firm surface	2.5
Walking, 2.5 mph, downhill	2.8
Fishing, general	3
Cooking	3
Standing - light/moderate work (pack boxes, assemble/repair, set up chairs/furniture)	3
Driving heavy truck, tractor, bus	3
Carpet sweeping, sweeping floors	3.3
Walking, 3.0 mph, level, moderate pace, firm surface	3.3
Mopping	3.5
Archery (non-hunting)	3.5
Standing - moderate (lifting 50 lbs., assembling at fast rate)	3.5
Walking, for pleasure, work break	3.5
Scrubbing floors, on hands and knees, scrubbing bathroom, bathtub	3.8
Walking on job, 3.5 mph, in office, brisk speed, not carrying anything	3.8
Walking, 3.5 mph, level, brisk, firm surface, walking for exercise	3.8
Sweeping	4
Gardening, general	4
Gymnastics, general	4
Table tennis, ping pong (Taylor Code 410)	4
Tai chi	4
Standing - moderate/heavy work	4
Badminton, social singles and doubles, general	4.5
Golf, general	4.5
Cricket (batting, bowling)	5

Walking, grass track	5
Teaching aerobic exercise class	6
Jog/walk combination (jogging component of less than 10 minutes) (Taylor Code 180	6
Boxing, punching bag	6
Wrestling (one match = 5 minutes)	6
Walking, 3.5 mph, uphill	6
Walking, 4.5 mph, level, firm surface, very, very brisk	6.3
Aerobic, general	6.5
Jogging, general	7
Tennis, general	7
Wallyball, general	7
Bicycling, general	8
Running, 5 mph (12 min/mile)	8
Running, 5.2 mph (11.5 min/mile)	9
Running, 6 mph (10 min/mile)	10
Swimming, butterfly, general	11

[57]

**MET= metabolic equivalent of task; the ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hr and is roughly equivalent to the energy cost of sitting quietly.*

ANNEXURE- 1:

Physical Activity Consensus Group

Conceptualization, Execution and Steering Committee: Anoop Misra, Priyanka Nigam, Andrew P Hills, Davinder S Chadha.

Core Faculty and Expert Panelists: Anoop Misra, Priyanka Nigam, Andrew P Hills, Davinder S Chadha.

Lead Groups for Manuscript Preparation: Anoop Misra, Priyanka Nigam, Andrew P Hills, Davinder S Chadha, Vineeta Sharma, KK Deepak, Naval K Vikram, Shashank Joshi, Ashish Chauchan, Kumud Khanna, Rekha Sharma, Kanchan Mittal , Santosh Jain Passi, Veenu Seth , Seema Puri , Ratna Devi, AP Dubey, Sunita Gupta

Other Participating Faculty**:
National: A P Dubey, A Saxena, Abha Saxena, Anand N. Malaviya*, Anju Ghei, Anura Kurpad* , Ashish Chauchan, Ashok Kumar Duggal, Ashok Trisal*, C S Pandav, Chandra Sekhar, D D Arora, Deeksha Kapur, Dheeraj Bhatia, G M Mathur, G M Singh, G R Sridhar*, Isha Kashiva, J M Bahnot, Jagmeet Madan*, Jasmin Kaur, Jeena Mathew, Jharna das Gupta, K K Pant, K K Shukla, Kanchan Mittal, Kanika Kapoor, Kaushal Madan, Kumud Khanna, Lokesh Pant, Lokesh Pant, M N Misra, Mala Munral, Manu Chaudhary, Md Khurshid, Meenakshi Sharma, Meeta Mathur, Mekhala Chandra, Nammita Bhatia, Naresh Chawla, Naval K Vikram, Neelanjana Singh, Neha Gupta, Nidhi Kaushik, Nidhi Sharma, Nikhil Gupta, P H Mishra, Padam Singh, Pooja Puri, Priyali Shah, Puneet Misra, R C Lall, Rakesh Parikh*, Ramesh Mohan, Ratna Devi, Ravi Upadhaya, Ritesh Gupta, Ritu Jain, Ruchika Guglani, S K Agarwal, Santosh J Passi, Sarswati Sarkar, Satinath Mukhopadhyay*, Seema Puri, Seema Gulati, Shashi P Gupta, Shashank Joshi*, Sheel Nuna, Shelza Saluja, Shilpa Joshi*, Shubhra Atrey, Shuchee Madhusudan, Smita Dixit, Sonal Gupta, Srikant Sharma, Subir Majumdar, Sunita Gupta, Suruchi Singh, Surya P Bhatt, Susan L Colles, Swat Bharadwaj, Veenu Seth, Vidya.

International*: Abdul Hamid Zargar, Ajay Sood, Anil Bhoraskar, Anuj Bhargava, Anushka Patel, Deepa Vasudevan, Enas Enas, Jamal Ahmad, Jiten Vora, Kris Vijay, Mario Soares, Ranjita Misra, Undurti N Das, Nikhil Dhurandhar, Nita Forouhi, Om Ganda, Prakash Deedwania, Raj Bhopal, Romesh Khardori, Subrina Jesmin, Sonia Anand, Sundar Mudaliar, Vijay Viswanathan, Vivian Fonseca.

***All names are in alphabetical order. *These individuals were not physically present but have actively contributed to the guidelines.*

Represented Institutions: Science for Equity, Empowerment and Development (SEED) Division, Department of Science and Technology, Ministry of Science and Technology, Government of India, New Delhi; Department of Diabetes and Metabolic Diseases, Fortis Hospital, New Delhi; Diabetes Foundation (India), New Delhi; National Foundation for Diabetes, Obesity and Cholesterol (N-DOC), New Delhi; Chronic Care Foundation, New Delhi; Command Hospital (Air Force), Bangalore; Queensland University of Technology (QUT), Australia; St. John's Research Institute, St. John's National Academy of Health Sciences, Bangalore; All India Institute of Medical Sciences, New Delhi; Lilavati & Bhatia Hospital, Mumbai; Nutrition Foundation of India, New Delhi; Indian Institute of Technology, New Delhi; Air force Central Medical Establishment, New Delhi; Department

of Nutrition, Institute of Home Economics, New Delhi; Lady Irwin College, New Delhi; Delhi Medical Association, New Delhi; Indian Medical Association, New Delhi; Indian Spinal Injury Centre, New Delhi; Sir Gangaram Hospital; New Delhi; Max healthcare hospital, New Delhi; Euphoria Foundation; Pushpawati Singhania Research Institute, New Delhi.

References:

1. *International Diabetes Federation: Diabetes Facts. http://www.idf.org. 2010Accessed on November 10, 2010.*
2. Misra, A. and L. Khurana, *Obesity and the metabolic syndrome in developing countries.* J Clin Endocrinol Metab, 2008. **93**(11 Suppl 1): p. S9-30.
3. Misra, A., N. Singhal, and L. Khurana, *Obesity, the metabolic syndrome, and type 2 diabetes in developing countries: role of dietary fats and oils.* J Am Coll Nutr. **29**(3 Suppl): p. 289S-301S.
4. Kamath, S.K., et al., *Cardiovascular disease risk factors in 2 distinct ethnic groups: Indian and Pakistani compared with American premenopausal women.* Am J Clin Nutr, 1999. **69**(4): p. 621-31.
5. Hayes, L., et al., *Patterns of physical activity and relationship with risk markers for cardiovascular disease and diabetes in Indian, Pakistani, Bangladeshi and European adults in a UK population.* J Public Health Med, 2002. **24**(3): p. 170-8.
6. Viswanathan, M., et al., *Familial aggregation of type 2 (non-insulin-dependent) diabetes mellitus in south India; absence of excess maternal transmission.* Diabet Med, 1996. **13**(3): p. 232-7.
7. Knowler, W.C., et al., *10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study.* Lancet, 2009. **374**(9702): p. 1677-86.
8. Misra, A., *Prevention of type 2 diabetes: the long and winding road.* Lancet, 2009. **374**(9702): p. 1655-6.
9. Warburton, D.E., C.W. Nicol, and S.S. Bredin, *Health benefits of physical activity: the evidence.* Cmaj, 2006. **174**(6): p. 801-9.
10. *Physical Activity Guidelines Advisory Committee Report.*
11. Haskell, W.L., et al., *Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association.* Circulation, 2007. **116**(9): p. 1081-93.
12. Nelson, M.E., et al., *Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association.* Circulation, 2007. **116**(9): p. 1094-105.
13. Misra, A., et al., *Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management.* J Assoc Physicians India, 2009. **57**: p. 163-70.
14. Cooper, C., et al., *Childhood growth, physical activity, and peak bone mass in women.* J Bone Miner Res, 1995. **10**(6): p. 940-7.
15. Hills, A.P., N.A. King, and T.P. Armstrong, *The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: implications for overweight and obesity.* Sports Med, 2007. **37**(6): p. 533-45.
16. Janssen, I., et al., *Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns.* J Adolesc Health, 2004. **35**(5): p. 360-7.

17. Vandewater, E.A., M.S. Shim, and A.G. Caplovitz, *Linking obesity and activity level with children's television and video game use.* J Adolesc, 2004. **27**(1): p. 71-85.
18. Caroli, M., et al., *Role of television in childhood obesity prevention.* Int J Obes Relat Metab Disord, 2004. **28 Suppl 3**: p. S104-8.
19. Hesketh, K., et al., *Stability of television viewing and electronic game/computer use in a prospective cohort study of Australian children: relationship with body mass index.* Int J Behav Nutr Phys Act, 2007. **4**: p. 60.
20. Wrotniak, B.H., et al., *The relationship between motor proficiency and physical activity in children.* Pediatrics, 2006. **118**(6): p. e1758-65.
21. Stephens, T., D.R. Jacobs, Jr., and C.C. White, *A descriptive epidemiology of leisure-time physical activity.* Public Health Rep, 1985. **100**(2): p. 147-58.
22. Faigenbaum, A.D. and G.D. Myer, *Pediatric resistance training: benefits, concerns, and program design considerations.* Curr Sports Med Rep. **9**(3): p. 161-8.
23. *US Department of Health and Human Services: 2008 Physical Activity Guidelines for Americans. Washington, DC;*. 2008.
24. Faigenbaum, A.D., et al., *The effects of different resistance training protocols on muscular strength and endurance development in children.* Pediatrics, 1999. **104**(1): p. e5.
25. Davis, C.L., et al., *Effects of aerobic exercise on overweight children's cognitive functioning: a randomized controlled trial.* Res Q Exerc Sport, 2007. **78**(5): p. 510-9.
26. Sibley BA, E.J., *The relationship between physical activity and cognition in children: A meta-analysis.* Pediatric Exercise Science., 2003. **15**: p. 243-256.
27. Davy, K.P., et al., *Elevated heart rate variability in physically active young and older adult women.* Clin Sci (Lond), 1998. **94**(6): p. 579-84.
28. Amano, M., et al., *Exercise training and autonomic nervous system activity in obese individuals.* Med Sci Sports Exerc, 2001. **33**(8): p. 1287-91.
29. Singhal, N., et al., *Effects of controlled school-based multi-component model of nutrition and lifestyle interventions on behavior modification, anthropometry and metabolic risk profile of urban Asian Indian adolescents in North India.* Eur J Clin Nutr. **64**(4): p. 364-73.
30. Shah, P., et al., *Improvement in nutrition-related knowledge and behaviour of urban Asian Indian school children: findings from the 'Medical education for children/Adolescents for Realistic prevention of obesity and diabetes and for healthy aGeing' (MARG) intervention study.* Br J Nutr. **104**(3): p. 427-36.
31. DeMaio, M. and E.F. Magann, *Exercise and pregnancy.* J Am Acad Orthop Surg, 2009. **17**(8): p. 504-14.
32. Melzer, K., et al., *Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes.* Sports Med. **40**(6): p. 493-507.
33. Tobias, D.K., et al., *Physical activity before and during pregnancy and risk of gestational diabetes mellitus: a meta-analysis.* Diabetes Care.
34. Polley, B.A., R.R. Wing, and C.J. Sims, *Randomized controlled trial to prevent excessive weight gain in pregnant women.* Int J Obes Relat Metab Disord, 2002. **26**(11): p. 1494-502.

35. Sorensen, T.K., et al., *Recreational physical activity during pregnancy and risk of preeclampsia.* Hypertension, 2003. **41**(6): p. 1273-80.
36. Clapp, J.F., 3rd, *The effects of maternal exercise on fetal oxygenation and feto-placental growth.* Eur J Obstet Gynecol Reprod Biol, 2003. **110 Suppl 1**: p. S80-5.
37. Kobe, H., et al., *Effect of regular maternal exercise on lipid peroxidation levels and antioxidant enzymatic activities before and after delivery.* J Nippon Med Sch, 2002. **69**(6): p. 542-8.
38. Kasapis, C. and P.D. Thompson, *The effects of physical activity on serum C-reactive protein and inflammatory markers: a systematic review.* J Am Coll Cardiol, 2005. **45**(10): p. 1563-9.
39. Liu, C.J. and N.K. Latham, *Progressive resistance strength training for improving physical function in older adults.* Cochrane Database Syst Rev, 2009(3): p. CD002759.
40. Paterson, D.H. and D.E. Warburton, *Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines.* Int J Behav Nutr Phys Act. **7**: p. 38.
41. Baan, C.A., et al., *Physical activity in elderly subjects with impaired glucose tolerance and newly diagnosed diabetes mellitus.* Am J Epidemiol, 1999. **149**(3): p. 219-27.
42. Rastogi, T., et al., *Physical activity and risk of coronary heart disease in India.* Int J Epidemiol, 2004. **33**(4): p. 759-67.
43. Jolly, K., et al., *Home-based cardiac rehabilitation compared with centre-based rehabilitation and usual care: a systematic review and meta-analysis.* Int J Cardiol, 2006. **111**(3): p. 343-51.
44. Leon, A.S., et al., *Cardiac rehabilitation and secondary prevention of coronary heart disease: an American Heart Association scientific statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity), in collaboration with the American association of Cardiovascular and Pulmonary Rehabilitation.* Circulation, 2005. **111**(3): p. 369-76.
45. Taylor, R.S., et al., *Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials.* Am J Med, 2004. **116**(10): p. 682-92.
46. Thompson, P.D., *Exercise prescription and proscription for patients with coronary artery disease.* Circulation, 2005. **112**(15): p. 2354-63.
47. Vaz, M. and A.V. Bharathi, *Practices and perceptions of physical activity in urban, employed, middle-class Indians.* Indian Heart J, 2000. **52**(3): p. 301-6.
48. Shaw, J.E., R.A. Sicree, and P.Z. Zimmet, *Global estimates of the prevalence of diabetes for 2010 and 2030.* Diabetes Res Clin Pract. **87**(1): p. 4-14.
49. Gupta, R. and A. Misra *Type 2 diabetes in India: Regional disparities.* Br J Diabetes Vasc Dis, 2007. **7**: p. 12-16.
50. Misra, A., et al., *Effect of supervised progressive resistance-exercise training protocol on insulin sensitivity, glycemia, lipids, and body composition in Asian Indians with type 2 diabetes.* Diabetes Care, 2008. **31**(7): p. 1282-7.

51. Cuff, D.J., et al., *Effective exercise modality to reduce insulin resistance in women with type 2 diabetes.* Diabetes Care, 2003. **26**(11): p. 2977-82.
52. Ishii, T., et al., *Resistance training improves insulin sensitivity in NIDDM subjects without altering maximal oxygen uptake.* Diabetes Care, 1998. **21**(8): p. 1353-5.
53. Silverstein, J., et al., *Care of children and adolescents with type 1 diabetes: a statement of the American Diabetes Association.* Diabetes Care, 2005. **28**(1): p. 186-212.
54. Bhardwaj, S., et al., *Childhood obesity in Asian Indians: a burgeoning cause of insulin resistance, diabetes and sub-clinical inflammation.* Asia Pac J Clin Nutr, 2008. **17 Suppl 1**: p. 172-5.
55. Misra, A. and N.K. Vikram, *Clinical and pathophysiological consequences of abdominal adiposity and abdominal adipose tissue depots.* Nutrition, 2003. **19**(5): p. 457-66.
56. Guidelines, N.a.Y.H.D. and t.e. for Americans, Washington,
DC: US Government Printing Office;, 2005: p. 1-19.
57. Ainsworth, B.E., et al., *Compendium of physical activities: an update of activity codes and MET intensities.* Med Sci Sports Exerc, 2000. **32**(9 Suppl): p. S498-504.