# Physical activity and body mass index among women who have experienced infertility

Seddigheh Esmaeilzadeh, Mouloud Agajani Delavar, Zahra Basirat, Hamid Shafi

Fatemezahra Infertility and Reproductive Health Research Center, Department of Obstetrics and Gynecology, Babol University of Medical Sciences, Babol, Iran

**Submitted:** 26 August 2012
**Accepted:** 6 November 2012

Arch Med Sci 2013; 9, 3: 499-505
DOI: 10.5114/aoms.2013.35342


**Corresponding author:**
Mouloud Agajani Delavar
MSc, PhD
Department of Midwifery
Babol University
of Medical Sciences
Ganjafroz
2247136 Babol, Iran
Phone: +981113260714
E-mail:
moloodaghajani@yahoo.com

## Abstract

**Introduction:** The experience of infertility is a common medical condition in the developing countries. The aim of this retrospective epidemiologic study was to determine fertility status and parity in Babol, Iran and then identify physical activity and body mass index (BMI) among women who have experienced infertility.
**Material and methods:** A total of 1,081 women aged 20-45 years were selected using cluster sampling. The current physical activity was measured using the original International Physical Activity Questionnaire short form. Lifestyle factors were compared between those who had experienced infertility ($n$ = 168) and the rest of the women. A face-to-face household interview was conducted using a specially designed interview questionnaire.
**Results:** After adjusting for suspected confounding factors, women with infertility experience had a 4.8-fold increased risk of obesity (OR = 2.02, CI = 0.70, 5.84) and almost a 3.8-fold increased risk of being overweight (OR = 2.11, CI = 0.72, 6.17) compared to women without infertility. No significant differences were found in Met-minutes of sedentary activity, intensity of walking, moderate, vigorous, and total physical activity, self-reported dietary intake, exercise, and level of physical activity between women with and without experience of infertility.
**Conclusions:** Since both obesity and infertility are increasing public health issues in Iranian women, more attention should be paid to lifestyle behaviors, especially gaining weight in women who have experienced infertility.

**Key words:** physical activity, epidemiology, body mass index, infertility, women.

## Introduction

Infertility is the most important reproductive health problem in developing countries, with the lifetime prevalence rate ranging from 6.6% [1] to 32.6% [2]. Infertility can affect the whole life and it is associated with dysthymia, anxiety and more disease [3]. However, in most developing countries, reproductive health care is synonymous with family planning [4]. Attention is given only to the decreasing number of births in these countries but infertility care is given little or no attention [5]. Data from Iran suggested that there are increasing numbers of infertile couples, and only 30-50% of them could afford to pay for treatment [6]. Obesity has become a common factor among Iranian women due to changed lifestyle factors such as physical inactivity and adoption of a western lifestyle. Lifestyle factors such as physical activity and body mass index can impact general health and well-being [7-10]. The effect of lifestyle on reproduc-

tive performance depends on individual etiology and circumstance [11]. Most studies of fertility and body mass index have focused on women's health. Those reporting public health have found that lower, or higher body mass index are significantly associated with infertility [8, 12, 13]. It is suggested that the impact of body mass index is much greater than the impact of public health [14]. Overweight and obese women who are at higher risk of infertility may improve their fertility with physical activity [15].

Despite the existence of the literature on lifestyle factors of infertility, there are few published reports on health behavior in women who have experienced infertility. In the present study, we investigated the fertility status and parity in married women under 45 years and then examined several lifestyle factors, physical activity and BMI in women having experienced infertility.

## Material and methods

A retrospective, descriptive, epidemiological study was conducted on lifestyle factors associated with infertility in urban and rural women in Babol, Iran. The required sample size was calculated to be 1,414. Cluster sampling proportionate to population size, with 120 clusters and 12 subjects in each cluster, was used to identify potential participants. Inclusion criteria for the study were: being married for at least one year, aged 20 to 45 years, being mentally sound, and having the ability to understand a questionnaire with the help of an interviewer. The sampling frame was comprised by the list of census enumeration areas with population and household information from the 2009 Population Census. Each of the six districts in Babol County was subdivided into one or two cities and rural aggregations. The primary sampling unit (PSU) for this study was a ward in urban areas, or village in rural areas. Because the total number of wards and villages was relatively equal, at the first stage of sampling 120 PSU (60 in urban areas and 60 in rural areas) were randomly selected. A standard cluster sampling technique was used because it allowed a small number of PSUs with the largest population to be studied while providing statistically valid data. At the second stage of sampling, about 12 households per PSU on average in urban areas and about 12 households per PSU on average in rural areas were selected. Every selected cluster was approached by the supervisors and team leaders to identify eligible women who fulfilled the selection criteria after taking consent. A starting household was randomly selected in each cluster. Each house after the first one was surveyed until the entire selected cluster had been surveyed. Of a total of 1,414 women seen at their home, 59 (5.2%) were voluntarily childless and 274 (19.4%) did not want to participate in this study; thus a total of 1,081 interviews were completed with a participation rate of 80.6%.

### Data collection

The study included a home interview, a thorough health examination carried out by trained, skilled personnel on fertility status and several self-administered questionnaires. This study was approved by Babol University of Medical Sciences for ethics in medical research. Written informed consent was obtained from all participants in the study. Fertility status and cause of infertility were assessed by a self-reported questionnaire. Infertility referred to a delay in conception for at least 12 months of unprotected intercourse. Lifetime infertility in this study was considered as couples who had experienced infertility as defined above at some time during their married life. Voluntary childlessness was defined by not reporting having problems with becoming pregnant or childbirth [16]. The validity and reliability of the questionnaire were assessed by pretesting. The $\alpha$ coefficient and internal consistency of infertility were 0.80 and 0.89, respectively.

Physical activity was measured using the original International Physical Activity Questionnaire (IPAQ) short, usual week form [17, 18]. The weight of the women was recorded using digital scales to the nearest 100 g, with the participant minimally clothed and without shoes. Height was measured with a tape measure, with the participant barefoot [17]. Body mass index was calculated using the formula of weight (kg)/height$^2$ (m) [19].

### Statistical analysis

All analyses were performed with SPSS (version 16.0). Status of fertility and parity for different levels of characteristics was compared using descriptive and $\chi^2$ statistics. The final multivariate model included as dependent variables factors that were related to the outcome of lifetime infertility at $p = 0.2$ in the bivariate analyses. To test the association between physical activity and body mass index with infertility, stepwise multiple logistic regression was used. Odds ratios (ORs) were assessed using maximum likelihood and associated 95% confidence intervals (CIs) were computed. All independent variables that met the above criteria were included in the multiple logistic regression. A $p$ value of 0.05 or less was considered significant.

## Results

A total of 1,081 women with a mean age of 33.7 ±6.9 years and median age of 33.0 years participated in the study. The mean educational duration was 10.2 ±4.2 years. The mean and median BMI of

the study population were 27.6 ±4.8 kg/m$^2$ and 27.3 kg/m$^2$, respectively. The participants had a mean marriage age of 19.9 ±4.5 years. Among married women, the parity number ranged from 0 to 6 with a mean number of 1.9 ±0.9 births. Significant differences were observed in age ($p$ = 0.0001), age at marriage ($p$ = 0.0001), education ($p$ = 0.0001), own occupation ($p$ = 0.0001), and body mass index ($p$ = 0.0001), between these women, either with (1, 2, and 3 or more children) or without children (Table I).

The prevalence of lifetime experienced infertility was 15.5%. A significant statistical difference was found in age at marriage ($p$ = 0.004), number of children ($p$ = 0.0001), and body mass index ($p$ = 0.046) between women with and without experienced infertility (Table II).

The mean Met-minutes of physical activity per week – vigorous and moderate walking and total physical activity – were 2254.5 ±5816.8, 1891.9 ±840.0, and 4588.2 ±1999.5, respectively. No signif-

**Table I.** Characteristics of participants according to parity ($n$ = 1,081)

| Variable | Mean ± SD | No children ($n$ = 47) | 1-2 children ($n$ = 811) | 3 or more children ($n$ = 223) | Value of $p$ |
|---|---|---|---|---|---|
| Age [years] | | | | | |
| < 35 | 1.5 ±1.5 | 29 (61.7) | 554 (69.5) | 31 (13.9) | < 0.001 |
| ≥ 35 | 2.4 ±1.0 | 18 (38.3) | 247 (30.5) | 192 (86.1) | |
| Age of marriage [years] | | | | | |
| < 19 | 2.1 ±1.1 | 10 (21.3) | 316 (39.0) | 135 (60.5) | < 0.001 |
| 19-35 | 1.6 ±0.9 | 32 (68.1) | 492 (60.7) | 87 (39.0) | |
| > 35 | 0.7 ±1.0 | 5 (10.6) | 3 (0.4) | 1 (0.4) | |
| BMI [kg/m$^2$] | | | | | |
| Underweight (< 20) | 1.4 ±0.8 | 3 (6.5) | 37 (5.0) | 2 (0.9) | < 0.001 |
| Normal weight (20-24.9) | 1.7 ±0.9 | 18 (39.1) | 239 (32.5) | 50 (23.4) | |
| Overweight (25-29.9) | 1.9 ±0.8 | 12 (26.1) | 215 (29.2) | 43 (20.1) | |
| Obese (≥ 30) | 2.2 ±1.1 | 13 (28.3) | 245 (33.3) | 119 (55.6) | |
| Years of education completed | | | | | |
| < 9 | 2.4 ±1.1 | 14 (29.8) | 208 (25.6) | 153 (68.6) | < 0.001 |
| 9-12 | 1.7 ±0.8 | 17 (36.2) | 383 (47.2) | 61 (27.4) | |
| > 12 | 1.5 ±0.7 | 16 (34.0) | 220 (27.1) | 9 (4.0) | |
| Own occupation | | | | | |
| Manager/professor | 1.6 ±0.7 | 6 (12.8) | 97 (12.0) | 4 (1.8) | < 0.001 |
| Intermediate | 2.0 ±1.0 | 3 (6.4) | 76 (9.4) | 33 (14.8) | |
| Routine and manual occupation | 1.9 ±1.0 | 38 (8.9) | 638 (78.7) | 186 (83.4) | |
| Level PA | | | | | |
| Low | 1.9 ±0.9 | 18 (38.3) | 203 (25.0) | 54 (24.5) | 0.166 |
| Moderate | 1.8 ±1.0 | 9 (19.1) | 136 (16.8) | 32 (14.3) | |
| High | 1.9 ±0.9 | 20 (42.6) | 472 (58.2) | 137 (61.4) | |
| Sedentary [min/day] | | | | | |
| < 60 | 1.8 ±0.9 | 1 (2.1) | 46 (5.7) | 11 (4.9) | 0.663 |
| 60-240 | 1.9 ±0.9 | 30 (63.8) | 500 (61.7) | 130 (58.3) | |
| > 240 | 1.9 ±0.9 | 16 (34.0) | 265 (32.7) | 82 (36.8) | |
| Walking [min/day] | | | | | |
| < 11 | 1.9 ±1.0 | 23 (48.9) | 363 (44.8) | 97 (43.5) | 0.972 |
| 11-40 | 1.9 ±1.0 | 10 (21.3) | 181 (22.3) | 50 (22.4) | |
| > 40 | 1.9 ±0.9 | 14 (29.8) | 14 (29.8) | 76 (34.1) | |

*BMI – body mass index, PA – physical activity*

**Table II.** Characteristics of participants according to fertility status ($n$ = 1,081)

| Variable | Experienced infertility ($n$ = 168) $N$ (%) | No infertility ($n$ = 913) $N$ (%) | Value of $p$ |
|---|---|---|---|
| Age [years] | | | |
| < 35 | 100 (59.5) | 524 (57.4) | 0.060 |
| ≥ 35 | 68 (40.5) | 389 (42.8) | |
| Age at marriage [years] | | | |
| < 19 | 71 (92.3) | 390 (42.7) | 0.004 |
| 19-35 | 92 (54.8) | 519 (56.8) | |
| > 35 | 5 (3.0) | 4 (0.4) | |
| Marital status | | | |
| Married | 165 (98.2) | 884 (96.8) | 0.328 |
| Divorced/widowed | 3 (1.8) | 29 (3.2) | |
| Years of education completed | | | |
| < 9 | 61 (36.3) | 314 (34.4) | 0.820 |
| 9-12 | 68 (40.5) | 393 (43.0) | |
| > 12 | 39 (23.2) | 206 (22.6) | |
| Own occupation | | | |
| Manager/professor | 15 (8.9) | 92 (10.1) | 0.169 |
| Intermediate | 11 (6.5) | 101 (11.1) | |
| Routine and manual occupation | 142 (84.5) | 720 (78.9) | |
| Partner occupation | | | |
| Manageable or professor | 41 (24.4) | 232 (25.4) | 0.915 |
| Intermediate | 109 (64.9) | 577 (63.2) | |
| Routine and manual occupation | 18 (10.7) | 104 (11.4) | |
| Long-term health problems | | | |
| Yes | 47 (41.2) | 218 (23.9) | 0.256 |
| Past history of reproductive problems | | | |
| Yes | 53 (31.5) | 261 (28.6) | 0.437 |
| Number of children | | | |
| No children | 46 (93.9) | 3 (6.1) | < 0.001 |
| 1-2 children | 106 (13.1) | 703 (86.9) | |
| 3 or more children | 16 (9.5) | 207 (92.8) | |
| IUD use | | | |
| Yes | 12 (7.1) | 98 (10.7) | 0.157 |
| OCP use | | | |
| Never | 104 (61.9) | 526 (57.6) | 0.746 |
| At least 2 years | 19 (11.3) | 113 (12.4) | |
| > 2 years | 23 (13.7) | 161 (17.6) | |
| User | 13 (7.7) | 68 (7.4) | |
| Unknown | 9 (5.4) | 45 (4.9) | |
| Tubal sterilization | | | |
| Yes | 16 (9.5) | 139 (15.2) | 0.298 |
| BMI [kg/m$^2$] | | | |
| < 25.0 | 47 (13.5) | 302 (86.5) | 0.046 |
| ≥ 25.0 | 532 (82.2) | 115 (17.8) | |

**Table II.** Cont.

| Variable | Experienced infertility ($n$ = 168) *N* (%) | No infertility ($n$ = 913) *N* (%) | Value of $p$ |
|---|---|---|---|
| Smoking status | | | |
| Current or ex-smoker | 34 (20.2) | 222 (24.3) | 0.603 |
| Never smoked | 134 (79.8) | 291 (75.7) | |
| Alcohol use | | | |
| Yes | 2 (1.2) | 6 (0.7) | 0.459 |
| Partner alcohol use | | | |
| Yes | 5 (3.0) | 37 (4.1) | 0.597 |
| Self-reported dietary status | | | |
| Good | 160 (95.2) | 880 (96.4) | 0.474 |
| Bad | 8 (4.8) | 33 (3.6) | |
| Exercise | | | |
| Yes | 105 (62.5) | 524 (57.4) | 0.217 |
| Level PA | | | |
| Low | 49 (17.6) | 229 (82.4) | 0.478 |
| Moderate | 28 (16.6) | 147 (42.0) | |
| High | 91 (14.5) | 537 (85.5) | |

*BMI – body mass index, PA – physical activity*

icant differences were found in Met-minutes of sedentary activity, intensity of walking, moderate, vigorous, and total physical activity, age, marital status, education, own occupation, partner occupation, long-term health problem, smoking, partner smoking, alcohol consumption, partner alcohol consumption, self-reported dietary intake, exercise, level of physical activity and contraception use between women with and without experienced infertility.

After adjusting for possible confounding variables – age, marital status, education, own occupation, partner occupation and area – women with infertility experience had higher marriage age (OR = 1.10, CI = 1.03, 1.11), fewer children (OR = 0.26, CI = 0.19, 0.35) and their body mass index was higher (OR = 1.05, CI = 1.02, 1.10) compared to women who had not experienced infertility.

After adjusting for age, smoking age of marriage, area, past history of sexually transmitted disease, pelvic inflammatory disease and contraception, own occupation, body mass index, significant associations were not found in level of physical activity, sedentary activity, or walking physical activity between these women either with or without experience of infertility. After adjusting for suspected confounding factors, women with infertility experience had a 4.8-fold increased risk of being obese (OR = 2.02, CI = 0.70, 5.84) and almost a 3.8-fold increased risk of being overweight (OR = 2.11, CI = 0.72, 6.17) in comparison to women without experience of infertility (Table III).

**Table III.** Adjusted OR for logistic regression for the association of lifetime infertility with physical activity, body mass index, age at marriage, and number of children ($n$ = 1,081)

| Variable | Adjusted OR | 95% CI | Value of $p$ |
|---|---|---|---|
| Level PA | | | |
| Low | 1.30 | 0.84-2.02 | 0.240 |
| Moderate | 1.04 | 0.64-1.68 | 0.810 |
| High | 1.00 | | |
| Sedentary (sitting) [min/day] | | | |
| < 60 | 10-46 | 0.72-2.99 | 0.299 |
| 60-240 | 0.72 | 0.50-10.06 | 0.094 |
| > 240 | 1.00 | | |
| Walking [min/day] | | | |
| < 11 | 1.06 | 0.71-1.55 | 0.784 |
| 11-40 | 0.93 | 0.58-1.49 | 0.766 |
| > 40 | 1.00 | | |
| BMI [kg/m$^2$] | | | |
| Obese (≥ 30) | 4.84 | 1.02-23.02 | 0.047 |
| Overweight (25.0-29.9) | 3.76 | 1.02-13.89 | 0.047 |
| Normal (20-24.9) | 2.19 | 0.70-6.88 | 0.180 |
| Underweight (< 20.0) | 1.00 | | |
| Age at marriage [years] | 1.07 | 1.03-1.11 | < 0.001 |
| Number of children | 0.261 | 0.19-0.35 | < 0.001 |

*PA – physical activity, BMI – body mass index*

## Discussion

This study presents general information regarding lifestyle of women 20-45 years old (rural and urban women). We used these data to compare physical activity and body mass index of women who had experienced infertility with fertile women. About 1 in 7 women reported experienced infertility.

We found that women with experienced infertility had increased risk of overweight and obesity in the adjusted analysis. This finding is in contrast with a study in which body mass index was similar between women with and without experienced infertility [3]. However, several studies have reported that overweight/obesity increases the risk of ovulatory infertility and infertile women are more overweight [20, 21].

Some studies have shown that infertility is directly related to current smoking and alcohol consumption [14, 22, 23]. However, we found no significant difference between groups in reporting of smoking and alcohol consumption. Our findings are in agreement with a study showing that frequency of smoking was similar between women with and without experienced infertility [3]. In addition, recall bias was possible in lifestyle habits' assessment because of prohibition of alcohol consumption and smoking among women in Iran.

Physical inactivity is listed as a major modifiable risk factor of cardiovascular disease. It has been shown that physical activity contributes to the regulation of blood pressure [24] and body weight [15], and improves glucose tolerance [25, 26]. On the other hand, several studies have reported that physical activity affects the reproductive system [16, 27, 28]. Few studies, however, have evaluated the effect of physical activity on female infertility in the general population. The mechanisms whereby intensive physical activity raises the risk of infertility are not fully understood and probably intensive physical activity disrupts ovulation [29, 30]. In this study, we were not able to confirm a significant association between physical activity and lifetime infertility.

There are several strengths of the study. In this study recall bias was not a point of concern because women aged 20-45 years were selected, and it was easy for them to recall whether they had already tried to conceive and may therefore have experienced infertility. Also the data were collected in a general health study. Health care personnel did a home interview and health examination. They asked whether women had experienced infertility at any time of their life.

We believe that a cross sectional survey of this sort is feasible, is relatively easily organized, and can yield important information. However, our study has several limitations. We did not provide stronger evidence on risk factors of infertility. Another limitation is that this study could not identify the timing of the infertility experience and therefore we did not determine causality between infertility and lifestyle factors such as physical activity and body mass index based on the present study. However, the IPAQ measures physical activity during the previous 7 days and can be expected to have a lower level of recall bias than instruments attempting to measure physical activity that occurred over a longer period of time [31]. Misclassification by participants may occur due to errors in the interpretation of questions and estimation of duration, frequency and intensity of physical activity [32]. A large prospective study is needed to propose to elucidate associations between physical activity, body mass index and infertility in married women in Iran.

In conclusion, despite the limitations mentioned, this study showed that women with experienced infertility are at risk of overweight and obesity. Since both obesity and infertility are increasing public health issues in Iranian women, the result of the study may be useful for developing public health strategies for infertile women.

## Acknowledgments

The authors acknowledge the assistance of Babol University of Medical Sciences for their support, Iranian women for their participation in this study, and the assistance of Atieh Hassanpour, Shiva Golalizade, Maryam Abdi Bora, Sharareh Abedi, Mehrnoush Babazade, and Maryam Babazade in the sampling.

## References

1. Rostad B, Schei B, Sundby J. Fertility in Norwegian women: results from a population-based health survey. Scand J Public Health 2006; 34: 5-10.
2. Maheshwari A, Hamilton M, Bhattacharya S. Effect of female age on the diagnostic categories of infertility. Hum Reprod 2008; 23: 538-42.
3. Klemetti R, Raitanen J, Sihvo S, Saarni S, Koponen P. Infertility, mental disorders and well-being: a nationwide survey. Acta Obstet Gynecol Scand 2010; 89: 677-82.
4. Bergstrom S. Reproductive failure as a health priority in the Third World: a review. East Afr Med J 1992; 69: 174-80.
5. Hamberger L, Janson PO. Global importance of infertility and its treatment: role of fertility technologies. Int J Gynaecol Obstet 1997; 58: 149-58.
6. Iran: Increasing prevalence of infertility In: Iranian Labour News Agency IPCS, editor May 12, 2010.
7. Redman LM. Physical activity and its effects on reproduction. Reprod Biomed Online 2006; 12: 579-86.
8. Norman RJ, Noakes M, Wu R, Davies MJ, Moran L, Wang JX. Improving reproductive performance in overweight/obese women with effective weight management. Hum Reprod Update 2004; 10: 267-80.
9. Baczyk G, Opala T, Kleka P. Quality of life in postmenopausal women with reduced bone mineral density:

psychometric evaluation of the Polish version of QUALEFFO-41. Arch Med Sci 2011; 7:476-85.
10. Simeunovic S, Milincic Z, Nikolic D, et al. Physical activity evaluation in Yugoslav Study of the Precursors of Atherosclerosis in School Children – YUSAD study. Arch Med Sci 2010; 6: 874-8.
11. Homan GF, Davies M, Norman R. The impact of lifestyle factors on reproductive performance in the general population and those undergoing infertility treatment: a review. Hum Reprod Update 2007; 13: 209-23.
12. Rich-Edwards JW, Spiegelman D, Garland M, et al. Physical activity, body mass index, and ovulatory disorder infertility. Epidemiology 2002; 13: 184-90.
13. Hassan MA, Killick SR. Negative lifestyle is associated with a significant reduction in fecundity. Fertil Steril 2004; 81: 384-92.
14. Ramezanzadeh F, Kazemi A, Yavari P, et al. Impact of body mass index versus physical activity and calorie intake on assisted reproduction outcomes. Eur J Obstet Gynecol Reprod Biol 2012; 163: 52-6.
15. Wise LA, Rothman KJ, Mikkelsen EM, Sorensen HT, Riis AH, Hatch EE. A prospective cohort study of physical activity and time to pregnancy. Fertil Steril 2012; 97: 1136-42 e1-4.
16. Gudmundsdottir SL, Flanders WD, Augestad LB. Physical activity and fertility in women: the North-Trondelag Health Study. Hum Reprod 2009; 24: 3196-204.
17. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003; 35: 1381-95.
18. Questionnaire IPA. International Physical Activity Questionnaire 2005 [cited 2005 Available from: http://www.ipaq.ki.se/
19. Higgins D. Patient assessment. Part 1: calculation of body mass index. Nurs Times 2008; 104: 24-5.
20. Rich-Edwards JW, Goldman MB, Willett WC, et al. Adolescent body mass index and infertility caused by ovulatory disorder. Am J Obstet Gynecol 1994; 171: 171-7.
21. Grodstein F, Goldman MB, Cramer DW. Body mass index and ovulatory infertility. Epidemiology 1994; 5: 247-50.
22. Revonta M, Raitanen J, Sihvo S, et al. Health and life style among infertile men and women. Sex Reprod Health 2010; 1: 91-8.
23. Kelly-Weeder S, Cox CL. The impact of lifestyle risk factors on female infertility. Women Health 2006; 44: 1-23.
24. Moreau KL, Degarmo R, Langley J, et al. Increasing daily walking lowers blood pressure in postmenopausal women. Med Sci Sports Exerc 2001; 33: 1825-31.
25. DiPietro L, Seeman TE, Stachenfeld NS, Katz LD, Nadel ER. Moderate-intensity aerobic training improves glucose tolerance in aging independent of abdominal adiposity. J Am Geriatr Soc 1998; 46: 875-9.
26. Arciero PJ, Vukovich MD, Holloszy JO, Racette SB, Kohrt WM. Comparison of short-term diet and exercise on insulin action in individuals with abnormal glucose tolerance. J Appl Physiol 1999; 86: 1930-5.
27. Otis CL, Drinkwater B, Johnson M, Loucks A, Wilmore J. American College of Sports Medicine position stand. The Female Athlete Triad. Med Sci Sports Exerc 1997; 29: i-ix.
28. Green BB, Daling JR, Weiss NS, Liff JM, Koepsell T. Exercise as a risk factor for infertility with ovulatory dysfunction. Am J Public Health 1986; 76: 1432-6.
29. Bonen A. Recreational exercise does not impair menstrual cycles: a prospective study. Int J Sports Med 1992; 13: 110-20.
30. Bonen A, Shaw SM. Recreational exercise participation and aerobic fitness in men and women: analysis of data from a national survey. J Sports Sci 1995; 13: 297-303.
31. Durante R, Ainsworth BE. The recall of physical activity: using a cognitive model of the question-answering process. Med Sci Sports Exerc 1996; 28: 1282-91.
32. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport 2000; 71 (2 Suppl): S1-14.