LIFE CHANGE EVENTS AND PHYSICAL ACTIVITY: A Systematic Review

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October 2010
Abstract

Introduction: The increasing global epidemic of non-communicable diseases is closely related to changes in lifestyle, including decreasing physical activity levels. In many countries, physical inactivity is a major public health challenge. To respond to that challenge, it is essential to know which factors affect physical activity behavior. Certain life events may be one contributing factor, by creating emotional distress and disrupting a person’s daily routine.

Aim
The aim of this systematic review is to examine the effects of life events on changes in physical activity by focusing on the following life event categories: transition to college/university; change in employment status; marital transitions and changes in relationships; pregnancy and the postpartum period; and cancers.

Method
A systematic literature review was performed. To be included, studies had to measure at least one major change in life circumstance and a change in physical activity, by measuring physical activity at two time points at least (before and after life event). Forty-eight articles met the inclusion criteria and were reviewed.

Results
Studies examining effects of life events on physical activity are limited in number. The studies reviewed showed statistically significant changes in physical activity caused by certain life events. Transition to college or university, remarriage, mass urban disaster, and cancer diagnosis seem to decrease physical activity levels in men and women. Beginning work, changing work conditions, changing from being single to cohabiting, getting married, pregnancy and the postpartum period, and experiencing an interpersonal loss seem to decrease physical activity in women. In contrast, returning to study, divorce, and longer-term widowhood seem to increase physical activity in women. In addition, experiencing multiple life events during a certain time period seems to decrease physical activity participation in men and women.

Conclusions
Major life events seem to affect physical activity behavior. This means that people experiencing different life events could be an important target group for physical activity promotion. More research is needed to examine the short- and long-term effects of different life events on physical activity.
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Definitions

Physical activity
“Any force exerted by skeletal muscles that results in energy expenditure above resting level” (1).

Sport
Physical activity that usually involves some form of competition (1).

Exercise
Physical activity that usually involves improving fitness and health (1).

Health-enhancing physical activity
“Any form of physical activity that benefits health and functional capacity without undue harm or risk” (2).

Intensity of physical activity
The amount of effort made by an individual when engaging in specific physical activity (1).

Moderate-intensity physical activity
Raises the heart-beat and leaves the person feeling warm and slightly out of breath. Increases the body’s metabolism to 3-6 times the resting level (3-6 metabolic equivalents, METs) (1).

Vigorous-intensity aerobic physical activity
Enables people to work up a sweat and become out of breath. Usually involves sport or exercise, for example running. Raises the body’s metabolism to at least 6 times its resting level (6 METs) (1).

Life change events
“Those occurrences, including social, psychological and environmental, which require an adjustment or effect a change in an individual’s pattern of living” (3).
1 INTRODUCTION

1.1 Benefits of physical activity

The increasing global epidemic of non-communicable diseases such as cardiovascular diseases, cancer, diabetes and chronic respiratory diseases are closely related to certain lifestyles, mainly tobacco use, physical inactivity and an unhealthy diet. The rise in obesity rates and associated health conditions contributes substantially to the global burden of disease, death and disability. Current scientific evidence suggests that physical activity reduces the risk of heart diseases, stroke, overweight and obesity, type 2 diabetes, colon cancer, breast cancer, depression and falls, and, among older people, hip fractures. Weight-bearing activities help to prevent osteoporosis (1), (4), (5), (6). In addition, there is evidence that physical activity is beneficial in the treatment of metabolic syndrome-related disorders (insulin resistance, type 2 diabetes, dyslipidemia, hypertension, obesity), heart and pulmonary diseases (chronic obstructive pulmonary disease, coronary heart disease, chronic heart failure, intermittent claudication), muscle, bone and joint diseases (osteoarthritis, rheumatoid arthritis, osteoporosis, fibromyalgia, chronic fatigue syndrome) and cancer, depression, asthma, type 1 diabetes, overweight and obesity (7), (8). In addition to preventing and limiting the progression of many non-communicable diseases, physical activity improves physical fitness, muscular strength and quality of life.

Physical activity affects psychological well-being by reducing the symptoms of depression and possibly stress and anxiety (1). Growing evidence suggests that physically active people are at reduced risk of developing depression, and that exercise interventions reduce anxiety, reduce the symptoms of panic disorder, and benefit patients with mild to moderate forms of depression (9), (10). Aerobic exercise can cause an acute improvement in mood and a reduction in the perception of pain from a painful stimulus (11). There is also limited evidence that, on a longer-term basis, moderate exercise improves mood (or helps maintaining it at high levels), while intense exercise may lead to a deterioration in mood due to its relation to excessive exercise and overtraining syndrome (12).

Physical activity has also been associated with other psychological and social benefits such as building social skills and better self-esteem, and, among women, positive self-image (1). Evidence indicates that exercise has positive short-term effects on self-esteem also among children and adolescents (13). Some patients with chronic fatigue syndrome may benefit from exercise therapy (14).
Physical activity may promote other positive health behaviors, such as nonsmoking, a decrease in alcohol consumption and healthier eating habits. In addition, physical activity benefits society by increasing social interaction and community engagement (1). Generally, the least active people in the population have the highest risk of a variety of negative health outcomes. Although the minimum amount of physical activity which decreases the risk is not known, even some physical activity seems to be better than none (6). The economic consequences of physical inactivity are substantial because of the increasing health care costs. However, the indirect costs, which include the value of economic output lost because of illness, disease-related work disabilities and premature death, are even greater (15). By improving people’s physical and mental health, physical activity benefits individuals’ as well as society’s economy. Because of a decrease in health-enhancing physical activity levels, physical inactivity is seen as a major public health challenge in many countries (1).

1.2 Physical activity recommendations

Adults

To promote and maintain health, the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) recommend that healthy adults aged 18 to 65 years engage in moderate-intensity aerobic physical activity for a minimum of 30 minutes five days a week. Alternatively, vigorous-intensity aerobic physical activity for a minimum of 20 minutes three days a week or a combination of moderate-intensity and vigorous-intensity activities can be performed. Shorter bouts of physical activity of at least 10 minutes each can be accumulated throughout the day to meet the 30-minute recommendation. These recommended amounts of aerobic activity should be done in addition to light intensity routine activities of daily living (16).

In addition to aerobic activity, activities that maintain or increase muscular strength and endurance should be performed at least two days a week. Because of the dose-response relation between physical activity and health, exceeding the minimum recommended amounts of physical activity may result in greater benefits in improving fitness, reducing the risk of chronic diseases and disabilities, and preventing unhealthy weight gain (16).

The World Cancer Research Fund (WCRF) recommends moderate physical activity, equivalent to brisk walking, for at least 30 minutes every day. This can be incorporated in occupational, transport, household, or leisure activities. As fitness improves, the WCRF
recommends 60 minutes or more of moderate, or 30 minutes or more of vigorous, physical activity every day. This is because physical activity of longer duration or greater intensity is more beneficial (17).

The U.S. Department of Health and Human Services recommended in 2008 that all adults should avoid inactivity and that some physical activity is better than none. To gain substantial health benefits, adults should do at least 2 hours 30 minutes a week of moderate-intensity, or 1 hour 15 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate-intensity and vigorous-intensity aerobic activity. This should be performed in episodes of at least 10 minutes, and preferably it should be spread throughout the week. To gain additional and more extensive health benefits, adults should increase their aerobic physical activity to 5 hours a week of moderate-intensity, or 2 hours 30 minutes a week of vigorous-intensity physical activity, or an equivalent combination of these activities. Physical activity beyond this amount gives additional health benefits. In addition to aerobic physical activity, adults should also perform muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups on 2 or more days a week (14).

Children and adolescents

An expert panel in 2005 recommended, on the basis of a comprehensive literature review, that school-aged young people should participate in 60 minutes or more of physical activity per day, which should be developmentally appropriate, enjoyable, and involve a variety of activities (18). The U.S. Department of Health and Human Services recommended in 2008 that children and adolescents aged 6 to 17 should do physical activity for 60 minutes or more daily. Most of this 60 minutes or more per day should consist of either moderate-intensity or vigorous-intensity aerobic physical activity, and should include vigorous-intensity activity at least 3 days a week. In addition, 60 minutes or more a day should include muscle-strengthening physical activity on at least 3 days per week, and bone-strengthening physical activity on at least 3 days per week. The recommendation highlights the importance of encouraging young people to participate in physical activities that are appropriate for their age and enjoyable, and that offer variety. Regular physical activity in children and adolescent promotes health and fitness and can be an important foundation for life-long health-enhancing physical activity (14).
Older adults

The physical activity recommendation for older adults is similar to the ACSM/AHA (16) recommendations for adults, with some important differences (19). The intensity of aerobic activity should be planned according to the older adult’s aerobic fitness, and the physical activity plan should integrate preventive and therapeutic recommendations. Activities that maintain or increase flexibility are recommended, as well as balance exercises for older adults who are at risk of falls. Moderate-intensity aerobic activities, risk management and muscle-strengthening activities are recommended (19). The U.S. Department of Health and Human Services recommended in 2008 that older adults should be as physically active as their abilities and conditions allow if they cannot do the recommended amounts of aerobic activity for adults. Older adults should perform exercises that maintain or improve balance if they are at risk of falling. The level of their effort for physical activity should be determined relative to their level of fitness. Chronic conditions should be taken into account when doing regular physical activity (14).

1.3 Current levels of physical activity

A survey in 2002 revealed that in the European Union countries almost one third (31%) of people aged 15 years or more reached recommended levels of physical activity (at least half an hour of moderate-intensity activity on most days of the week). The levels of physical activity differed substantially between different countries in the European Union (20). In 2005 and 2006, 5.510 participants aged 19 – 65 years were phone interviewed in a survey conducted in Finland. According to the results, 36 % of the participants (32% of men and 41% of women) were sufficiently active for health during their leisure-time (moderate-intensity or vigorous-intensity physical activity at least 4 times a week, at least 30 minutes a day) (21).

Data from 2005 show that 49.1% of U.S. adults were meeting the ACSM physical activity recommendation. A greater percentage of men (50.7%) than of women (47.9%) met the recommendation, and younger people were more active than older ones. Among young adults aged 18-24 years, 59.6% met the recommendation, whereas among older adults aged 65 years and older, only 39.0% did. Ethnicity seems to play a role in physical activity behavior among the U.S. adults. White, non-Hispanics were more active (51.1%) than other ethnic groups (16). Data from two national surveys (1999-2005) of respondents aged 18 years or older
revealed that one-quarter of U.S adults had participated in any sport, exercise, or recreational activity on a random day, and 60.9% had participated in any leisure-time activity in the previous 30 days (22). A survey conducted in Alberta, Canada, in 2008 showed that 58.5% of the participants aged 18 years and older (59.4% of the women and 57.7% of the men) were physically active enough to experience health benefits (men 38 METs per week and women 35 METs per week) (23). In Queensland, Australia, 59.3% of adults aged 20-75 years (61.9% of the men and 56.7% of the women) reported having sufficient levels of physical activity to achieve health benefits (i.e. reporting at least 150 minutes of physical activity a week) in 2004. The proportion of sedentary adults increased with age from 14% among those aged 20-39 years and 17.1% among those aged 40-59 years, to 20.0% among those aged 60-75 years (24).

A cross-sectional study by Zick et al. showed that physical activity declines over the 15 to 29 years age range (25). Other studies have also found an age-related decline in physical activity from childhood to adulthood (26), (27), (28), (29). Evenson et al. found, in a study population of 71,837 (a multiethnic group of women aged 55-79), that the prevalence of vigorous activity declined with age (18, 30, and 50 years and current) in the USA, with the largest decrease in vigorous activity occurring after 50 years for all ethnic groups. The same study also indicates that past vigorous activity predicts a present lack of vigorous activity, and that few participants (3-5 percent across ethnicity) sustained regular vigorous activity across the life span (30).

1.4 Life events, stress and physical activity

Life experiences that may significantly influence an individual’s daily routine are referred to as life change events or life events (31). They can be social, environmental, physical, psychological or a combination of these. Life events include: transition to a new school, moving to a new environment, obtaining a new job, a major change in one’s financial situation, a change in marital status, pregnancy, getting a new family member, death of a friend or a family member, and illness or injury. Life events may create emotional distress and disrupt a person’s daily routine. This may influence the commitment to be physically active. The effect of life events on physical activity is a poorly studied area of research (32).

Stressful events (i.e. deadlines at work, family demands) may influence health behaviors either by disrupting an individual’s ability to engage in health promoting behaviors or by increasing engagement in negative health-related behaviors. One study indicates that minor
stressors (every day inconveniences, frustrations, and hassles) disrupt exercise adherence and exercise-related cognitions (i.e. exercise enjoyment, satisfaction with week’s exercise and self-efficacy for meeting upcoming exercise goals) among women. During weeks with a high frequency of mildly stressful events (i.e. hurried to meet a deadline, had to make an important decision, had too many responsibilities, unable to finish all plans for the week, interrupted during a task, activity or thinking), the women exercised for less time and reported lower self-efficacy for meeting upcoming exercise goals. In addition, during weeks of high frequency of mildly stressful events, the women tended to omit more planned exercise sessions, enjoyed exercise less, and were less satisfied with their exercise (33). In contrast, one longitudinal study showed that an increase in daily hassles (small day-to-day irritations) was related to an increase in daily physical activity. However, the magnitude of the relationship was quite small (34). Another study found that positive moods were rated higher and depression lower on exercise days than on no-exercise days. Exercise was not associated with the experience of fewer daily stressors in the whole sample, but participants with low in trait anxiety reported fewer stressful events on the days on which they exercised (trait anxiety = tendency to experience anxiety). Those with strong personal motives for exercise (health, mood, and physical appearance) reported more stressful daily events overall, but they experienced more potentially stressful than non-stressful events on exercise days (35).

Some studies have examined the effect of physical activity during life events on psychological well-being. Students who had become insufficiently active during transition from high school to university reported higher levels of fatigue and lower levels of vigor compared with students who continued to be active (36). According to a review by Poudevigne et al. (2006), there is some evidence that inactivity during pregnancy is associated with a worse mood (37). Increasing sports or exercise activity from pre-pregnancy to postpartum has also been shown to be associated with better overall maternal well-being (38).

Longer-term widows have been shown to increase their level of physical activity and to show stability or a slight improvements in mental health (39). In addition, physical activity patterns across the cancer experience may be related to psychological well-being in adolescents after cancer diagnosis (40). However, it is unclear whether physical activity improved mental health or better mental health led to increased physical activity during the life events.

Exposure to physical and/or psychological stressors modulates the immune response. The impact that the stress response has on the immune function can be modulated by the duration
of stressor exposure, the perceived controllability of the stressor, the measure of the immune response, and the physiological state of the organism. Regular moderate physical activity has been shown to change stress physiology and blunt the negative impact of stress on the immune response in animals. This indicates that physically active organisms are more stress-resistant than their sedentary counterparts. Stress reduction may reduce the increased susceptibility and severity of infectious diseases caused by stress (41).

1.5 Previous studies on life change events and physical activity

Multiple life events

Cross-sectional studies have examined the relationship between the number of life events during a certain time period and subsequent physical activity at one time point. Some studies have found no association between physical activity participation and the number of life events experienced during the previous five years in adults (42) and during the previous 3 months in adolescents (43). One study found an association between an increased number of life events experienced and a decrease in physical activity participation in men (44). In contrast, another study showed that the presence of life events has a slight negative effect on physical activity for females and a slight positive effect for males (45).

Transition to college/university

Transition to college or university is characterized by change and adjustment in a number of life domains. Beginning college or university often leads to living away from home for the first time among other social, physical, emotional, and cultural changes. According to the United States 1995 Youth Risk Behavior Survey, 54.9% of high school seniors engaged adequately in vigorous physical activity (46). However, the US National College Health Risk Behavior Survey (1995) showed that only 35.3% to 39.6% of college and university students participated in adequate amounts of vigorous physical activity (47). However, comparison of these results is of limited value in that it shows only a cross-sectional decline in physical activity between two different U.S. populations. In addition, the latter research did not focus on first-year students, but on college students in general. Changes in physical activity behavior during transition to college or university may have important short- and long-term influences on an individual’s physical and mental well-being. In addition, a decline in physical activity when beginning college or university may lead to a pattern of inactivity that
persists in later life. There is consistent evidence that physical activity levels during adolescence are positively associated with physical activity levels in adulthood (48).

Employment status

Cross-sectional associations between not being in the labor force and physical inactivity among young women have been found (49). One study found that female college students who did not work while at college were less likely to be sufficiently physically active for health than those students who combined study and employment (50). In another study, employment relative to nonemployment was positively associated with participation in sports and exercise among women (51). Cross-sectional data suggest that leisure-time physical activity may increase during retirement (usually intensity of physical activity decreases and frequency increases), but little is still known about the effects of retirement on physical activity (52).

Marital status and relationships

A number of studies have examined the association between marital status and health behaviors. Most of the studies have been cross-sectional and have evaluated current marital status and not the effect of marital transition (53). The results of cross-sectional studies examining the association between marital status and physical activity are inconsistent. Some studies have reported that married people are less active than their single, widowed, or divorced counterparts (54), and some have found no association between marital status and exercise (55). One study found cross-sectional associations between divorce and widowhood in men and decreased participation in physical activity. Among women, the status of never having been married was associated with greater physical activity (56). Another study found that remaining single was consistently associated with high physical activity levels over a 2-year time period among both men and women. In addition, remaining married was associated with consistently low levels of physical activity among women (57). One cross-sectional study indicates that newly widowed elderly women may reduce their physical activity (58).

Pregnancy

The American College of Obstetricians and Gynecologists (2002) recommends that in the absence of either medical or obstetric complications, pregnant women should engage in 30
minutes or more of moderate exercise a day on most, if not all, days a week. However, a woman’s overall health, including obstetric and medical risks, should be evaluated before engaging in exercise. Participation in a wide range of physical activities is safe during pregnancy. However, each type of exercise should be considered individually and some physical activities should be avoided because of the physiologic and morphologic changes in pregnant women. These activities include activities with a high risk of falling or abdominal trauma, contact sports and scuba diving (59). A Scientific Roundtable Consensus Statement of the American College of Sports Medicine (2006) concluded that regular exercise during pregnancy has been proven to provide medical and psychological benefits to both mother and child. Physical activity may reduce the risk of preeclampsia in pregnant women and possibly prevent chronic musculoskeletal conditions (i.e. low back pain). Preliminary results concerning the treatment or prevention of gestational diabetes with physical activity are encouraging but more research is needed. The available evidence indicates that physical activity during pregnancy is associated with improved mental health during both the gestation and the postpartum period (60).

Postpartum period

Studies indicate that exercise improves aerobic fitness, plasma lipids and insulin response in breastfeeding women. Recreational weight-bearing exercise during pregnancy may have some positive short- and long-term effects on offspring outcome, but the information in this area is limited. Moderate exercise does not affect immunological component concentrations (sIgA, lactoferrin and lysozyme), vitamin B6, or essential fatty acids in breast milk (60). There is also limited evidence that there is a relationship between participation in exercise and reduction in postpartum depression (61). The postpartum period can be a potentially critical period for the development of obesity and it seems that healthy low-energy diet together with exercise is more effective than diet alone for losing weight after childbirth (62). The Health Sciences Descriptor of The American College of Obstetricians and Gynecologists (2002) recommends that after giving birth, pre-pregnancy exercise routines can be resumed gradually as soon as it is physically and medically safe. This varies in different individuals (59).

Pregnancy and change in physical activity

One review about physical activity patterns in pregnant women was published by Poudevigne and O’Connor in 2006 (37). The review evaluated 31 studies and found consistent evidence
that physical activity is reduced during pregnancy. The studies showed that both work-related and leisure time physical activity are decreased throughout pregnancy (37). One retrospective study in the review (n = 9953) found that the percentage of active women who reported exercising for $\geq 30$ minutes at least three times a week decreased from 55% before pregnancy to 42% after becoming pregnant (63). This occurred despite the fact that 7% of the women who were inactive before pregnancy became active during pregnancy. The studies in the review showed that both exercise intensity and duration decreased with pregnancy. There is a shift in mode toward activities that are less vigorous and perceived safer. The most frequently reported physical activities during the first and second trimester were walking, swimming, gardening, jogging, aerobic dance and “weight lifting”. Many studies found that leisure time physical activity decreased both during pregnancy compared with pre-pregnancy and at the end of pregnancy compared with the beginning of pregnancy. Overall, the number of women participating in vigorous physical activity decreased by 18 - 27% from the first trimester to the third (37). Because of the already existing review, studies about changes in physical activity during pregnancy are not analyzed in this paper. Studies assessing changes in physical activity from prepregnancy to postpartum are analyzed in this systematic review.

**Mass urban disaster or onset of chronic medical condition**

When an extraordinary event destroys goods, kills people, produces psychological and physical harm, and overcomes the adaptive possibilities of the social group, the event is a disaster. A disaster shakes the life of a community and raises questions about safety and the meaning of life, and has strong political consequences. Disasters are normally considered to be ‘chance’ events. Being involved in a disaster may cause severe stress reactions which may cause symptoms such as flashbacks, difficulties in remembering, avoidance of stimuli, blunting of responses, high arousal level and obsessive ruminations (64). These symptoms may affect an individual’s daily routines and health behaviors. One form of disaster is a terrorist attack (64). Terrorism assaults the mental health and well-being of the public and has the purpose of causing harm to everybody and to create panic, fear and anxiety. The September 11, 2001, attacks on the World Trade Center in New York created psychological distress for millions, caused mental disorders among some smaller groups, and threatened social cohesion (65).
An onset of a chronic medical condition (i.e. diabetes, high blood pressure, chronic lung disease or a heart attack) may also cause stress reactions and arouse worry about the future. This may influence the health behaviors of individuals.

Cancer

During cancer treatment, physical activity may have an effect in several important ways. It may help patients to cope with their disease physically and emotionally while awaiting treatments. It may also improve health and fitness sufficiently to allow demanding treatments to go forward, and possibly delay the need for treatment by managing the disease and its symptoms (66). Exercise during cancer treatment is associated with an improved quality of life, cardiorespiratory fitness, muscle strength, flexibility, decreased rates of anxiety, depression, fatigue, and pain. In addition, it is associated with anthropometric measures of body weight, body fat, waist and hip circumferences, and other health-related biomarkers such as blood pressure, heart rate, and circulating hormonal levels. The benefits of exercise after treatment are associated with improved cardiorespiratory fitness, muscle strength, hemoglobin concentration, decreased rates of depression, anxiety and fatigue, increased vigor and vitality, better body image, mental health, and quality of life. There is limited evidence that regular exercise may prevent the recurrence of cancer and improve survival among cancer survivors (i.e. anyone who has been diagnosed with cancer, from the time of diagnosis through the rest of her or his life) (67).

Cross-sectional studies of physical activity among cancer survivors show inconsistent results. Some studies (68), (69) found no differences in physical activity between cancer survivors and controls without cancer. One study found that cancer survivors were 9% more likely to meet physical activity recommendations compared with non-cancer controls (70), another study found, as expected, that patients with advanced cancer who were receiving chemotherapy were significantly less active than healthy controls (71). According to one study, 29.6% to 47.3% of cancer survivors were meeting the physical activity recommendation (72).

For cancer prevention, The American Cancer Society (ACS) recommends for the general population, at least 30 to 60 minutes of moderate to vigorous physical activity (above usual activities) at least 5 days a week. For cancer survivors, the ACS recommends engaging in physical activity according to the guidelines for the general population with the exception of
taking into account specific circumstances related to the treatment or other cancer-specific conditions. Ability to exercise may be affected by particular issues for cancer survivors, and the effects of treatment may promote the risk for exercise-related injuries and adverse effects. Survivors with severe anemia should delay other exercise than daily living until the anemia is improved, and those with compromised immune function should avoid public gyms until their white blood cell counts return to safe levels. Stretching may be more appropriate than other types of exercise for survivors suffering from severe fatigue after their therapy. Survivors undergoing radiation therapy should avoid chlorine exposure (swimming pools) to irradiated skin, while those with indwelling catheters should avoid water or other microbial exposures that may result in infections, as well as resistance training of muscles in the area of the catheter to avoid dislodgment. A stationary reclining bicycle may be better than walking for survivors with significant peripheral neuropathies or ataxia because of the problems with using the affected limbs due to weakness or loss of balance (73).

*Life change events and change in physical activity*

One systematic review (32) about life change events and participation in physical activity was published during the first literature search for this systematic review. The review was published in 2008 by Allender et al. They reviewed 19 articles and identified five broad life change categories: change in employment status; change in residence; change in physical status; change in relationships; and change in family structure. The authors noted that few longitudinal studies have examined physical activity both before and after a life event. Most of the studies included in their review examined relationship between physical activity and life change events with a cross-sectional design at one point in time, and used recall of physical activity status and/or life events. Some cross-sectional studies had measured physical activity only at one point in time without a retrospective measure of physical activity before the life event. Also in some longitudinal studies data on physical activity were not collected before and after the life event. The review suggests that life change events do affect participation in physical activity, and in light of changing participation rates, forms an important and neglected area of study. Based on the exclusion criteria used in this systematic review, only 9 out of 19 studies analyzed in the review by Allender et al. are analyzed in this systematic review (49), (74), (75), (76), (34), (56), (77), (78), (79).
2 AIM

The aim of this systematic review was to examine literature concerning the effects of life events on changes in physical activity in order to answer the following questions: 1. Does experiencing a life change event affect physical activity behavior? 2. Do different life change events have different kinds of effects on physical activity (does a certain life event decrease or increase physical activity)?

The life events included in this review are: transition to college/university; change in employment status (beginning work, changing work conditions, retirement); marital transitions and changes in relationships (cohabiting, marriage, separation, divorce, widowhood, interpersonal loss); pregnancy and the postpartum period; mass urban disaster; onset of chronic medical condition (i.e. diabetes, high blood pressure, chronic lung disease); and cancers.

3 METHODS

3.1 Database search

The Pubmed Medline database was searched for literature available as at March 2008 and an updated search was made in April 2009. The terms used in searching were: life change events (MeSH), physical activity (keyword), motor activity (MeSH), exercise (MeSH), health behavior (MeSH), life style (MeSH), cancer (keyword) and neoplasms (MeSH). The limits set in searching were: studies published in English, studies published after 1997, and studies concerning humans.

3.2 Assessment of the literature

Studies were evaluated using the following criteria:

- Study design – randomized controlled trial, longitudinal, cross-sectional
- Length of the study
- Study population – sample size, age of participants, representativeness of the general population
- Outcome measures - measures used, strengths and weaknesses of the measures used
- Limitations of the studies
4 RESULTS

4.1 Literature search

A combination of the key words ‘life change events’ and ‘physical activity’ yielded 36 articles, ‘life change events’ and ‘motor activity’ 11 articles, ‘life change events’ and ‘exercise’ 60 articles, ‘life change events’ and ‘health behavior’ 123 articles, ‘life change events’ and ‘exercise’ 30 articles, and ‘neoplasms’ and ‘motor activity’ 401 articles. Among all the articles, the ones focusing on the effects of life events on changes in physical activity were chosen and the related articles were reviewed for additional relevant articles. The references of selected articles were searched for other potentially relevant articles. After adding articles from related articles and reference lists, the exclusion criteria were applied (Table 1). Finally, a total of 48 articles (Tables 3-12) were reviewed in this systematic review, three of which examined more than one life event (74), (80), (57). Nine (49), (74), (75), (76), (34), (56), (77), (78), (79) out of 48 articles reviewed in this paper had been previously reviewed in the systematic review about life change in events and participation in physical activity by Allender et al. (32).

Table 1 Exclusion criteria

<table>
<thead>
<tr>
<th>Articles were excluded from this review if they:</th>
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<tbody>
<tr>
<td>did not include physical activity as one of the measured outcomes</td>
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<tr>
<td>did not measure a change in physical activity by measuring physical activity at two time points at least (before and after life event)</td>
</tr>
<tr>
<td>did not include change in life circumstance</td>
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<tr>
<td>did not report an effect of a life event on physical activity</td>
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</table>

4.2 Study characteristics

The characteristics of the studies reviewed in this paper (34), (81), (80), (36), (82), (75), (74), (83), (30), (52), (56), (57), (76), (49), (53), (84), (39), (80), (85), (86), (38), (87), (88), (89), (90), (77), (91), (92), (93), (94), (40), (95), (96), (97), (98), (99), (100), (101), (102), (78), (103), (79), (104), (105), (106), (107), (108), (109), (110) are shown in Table 2.
<table>
<thead>
<tr>
<th>Life event</th>
<th>Number of studies</th>
<th>Retrospective</th>
<th>Prospective longitudinal</th>
<th>Randomized controlled trial</th>
<th>Gender of the participants (number of studies)</th>
<th>Study origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple life events</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>M+F = 3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Transition to college/university</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>M+F = 2</td>
<td>2</td>
<td>1 1</td>
</tr>
<tr>
<td>Change in employment status</td>
<td>4</td>
<td>4</td>
<td></td>
<td>M+F = 2 F = 2</td>
<td>1 1 1</td>
<td>1</td>
</tr>
<tr>
<td>Marital transitions/changes in</td>
<td>9</td>
<td>8</td>
<td>1</td>
<td>M+F = 3 M = 1 F = 5</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnancy and postpartum</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>F = 6</td>
<td>4</td>
<td>1 1</td>
</tr>
<tr>
<td>Mass urban disaster</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M+F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Onset of chronic medical condition</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M+F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Multiple cancer types</td>
<td>8</td>
<td>8</td>
<td></td>
<td>M+F = 7 M = 1 (98%)</td>
<td>3</td>
<td>3 1 1 1</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>7</td>
<td>7</td>
<td></td>
<td>F = 7</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>M+F = 4 F = 1</td>
<td>2</td>
<td>2 1</td>
</tr>
<tr>
<td>Endometrial cancer</td>
<td>1</td>
<td>1</td>
<td></td>
<td>F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M+F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M+F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Head and neck cancer</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M = 1 (83%)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Multiple myeloma cancer</td>
<td>1</td>
<td>1</td>
<td></td>
<td>M+F = 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of studies</td>
<td>53</td>
<td>30</td>
<td>20</td>
<td>3</td>
<td>29</td>
<td>12 7 2 1 1</td>
</tr>
</tbody>
</table>

# The real number of studies because three studies examined more than one life event
M+F = males and females, M = males, F = females
4.3 Multiple life events

Three studies (34), (81), (80) examined the relationship between experiencing major life events during a certain time period and change in physical activity (Table 3). One study found no significant relationship between life events or the extent of impact of life events and physical activity in a 2-year follow-up study (34). A 2-year randomized controlled clinical trial of three different exercise conditions showed that life events did not have a significant impact on exercise adherence during the adoption of exercise behavior, but did show a significant negative effect during the maintenance phase of exercise behavior. In the maintenance stage of exercise participation, the occurrence of three or four life events was typically sufficient to significantly lower exercise adherence regardless of the exercise format or intensity (81). Another randomized controlled trial (1-year) showed that the total number of life events was negatively associated with participation in home-based exercise sessions, but not significantly associated with class-based exercise sessions among older adults. For men, there was no association between life events and exercise participation (80).
### Table 3 Multiple life events and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisk et al. 1999 The Netherlands (34) Longitudinal 2-year follow-up</td>
<td>N = 166 77 males 89 females (part of the AGHS study) at the age of 27</td>
<td>89 life events (in 5 domains: health, work, home/family, personal/social relations, finances)</td>
<td>Life events: LEL PA: a structured interview which covered the previous 3 months (all daily PA)</td>
<td>There was no significant relationship between life events or extent of impact of life events and physical activity.</td>
</tr>
<tr>
<td>Oman and King 2000 USA (81) 2-year RCT</td>
<td>N = 173 97 males 76 females Age (mean, SD) 56.5 ± 4.3 years</td>
<td>40 major life events</td>
<td>Life events: Questionnaire from the SRRS PA: - Participation in exercise groups (HI home-based, LI home-based, HI class-based) - Self-reported exercise logs (validation with heart rate and activity monitor)</td>
<td>The most often reported life events were major changes in working hours, major changes in the health or behavior of a family member, and major changes in eating habits. Life events did not have a significant impact on exercise adherence during the adoption of exercise behavior (months 1 to 6) but did show a significant negative effect during the maintenance phase of exercise behavior (months 7 to 24). In the maintenance stage of exercise participation, the occurrence of three or four life events was typically sufficient to significantly lower exercise adherence regardless of the exercise format or intensity. There were no significant differences in the effects of life events on exercise participation between different exercise formats or intensities. No significant differences emerged in the results between men and women.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Wilcox and King</th>
<th>N = 97</th>
<th>Life events: Questionnaire from the SRRS PA:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004 USA (80)</td>
<td>64% females</td>
<td>- Participation in class-based exercise sessions (moderate-intensity endurance and strengthening or stretching and flexibility)</td>
</tr>
<tr>
<td>1-year RCT</td>
<td>Age (mean, SD)</td>
<td>- Participation in home-based exercise sessions (self-reported exercise logs)</td>
</tr>
<tr>
<td></td>
<td>70.2 ± 4.1 years</td>
<td>- Clinical evaluations</td>
</tr>
</tbody>
</table>

The most common life events experienced by participants were a major change in the health of a family member, major changes in sleeping habits, the death of a close friend, and change in eating habits. The total number of life events was negatively associated with participation in home-based sessions ($r = -0.17, P < 0.05$) but not significantly associated with class-based sessions in the whole sample. For women, a trend emerged for total life events to negatively affect both home- and class-based exercise sessions. For men there was no association between life events and exercise participation.

Abbreviations:

AGHS = The Amsterdam Growth and Health Study (111), HI = higher intensity, LEL = The Life Events List (a version of the Life Events Survey (112)), LI = lower intensity, PA = physical activity, RCT = randomized controlled trial, SD = standard deviation, SRRS = The Social Readjustment Rating Scale (31)
4.4 Transition to college/university

Three studies (36), (82), (75) examined the change in physical activity after transition to college or university and one study (74) examined the change in physical activity after returning to study (after being at home or working for a while) (Table 4). Two studies with retrospective questionnaires found a significant decline in vigorous physical activity when transitioning from high school to university or college (36), (82). Females were less likely than males to engage in vigorous physical activity while at college when adjusted for high school vigorous physical activity. Among females, African Americans, Asians and students of lower socioeconomic position were less likely to engage in vigorous physical activity in college when adjusted for high school vigorous physical activity. Among males, Asians and older students were less likely to engage in vigorous physical activity. Participation in sports was a major determinant of vigorous physical activity at college (82).

A 5-month follow-up study showed that relocation from home to university led to significant decreases in total physical activity, occupational activities, and sport activities in female college freshmen. In contrast, leisure activities increased significantly. Fitness variables showed declines, but they were not significant (75). A 4-year longitudinal study found that young women who reported returning to study were significantly more likely to be active than those who did not return to study (stayed at home or continued working) (74).
Table 4 Transition to college/university and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bray et al. 2004 Canada (36)</td>
<td>N = 145 39 males 106 females Age (mean, SD) 18.14 ± 0.42 years (first-year university students)</td>
<td>Transition to university</td>
<td>Questionnaire (VPA during last 2 months of high school and 2 first months of university)</td>
<td>Significant decline (F (1.144) = 6.88, ( P = 0.01 )) in average frequency of VPA from 3.32 ± 2.12 to 2.68 ± 2.24 sessions per week. 66.2% were sufficiently active (USDHHS 2000 recommendations for minimum weekly vigorous activity) pre-transition and 44.1% during transition to university. 33.1% of the participants were continuously active, 22.8% were continuously insufficiently active, 11% were insufficiently active pre-transition but had become active during transition, and 33.1% were active pre-transition but had become insufficiently active during transition. No significant differences between men and women were found.</td>
</tr>
<tr>
<td>Nelson et al. 2007 USA (82)</td>
<td>N = 10 437 3748 males 6689 females Age groups: from 17 and under to 25 and older White 72% African American 7% Asian 9% Native American/other 10% Hispanic 8%</td>
<td>Transition to college</td>
<td>Questionnaire (current VPA: “Think back over the past 7 days. On how many days did you exercise or participate in PA for at least 20 minutes that made you sweat and breathe hard?” a similarly worded question assessed VPA in the final year of high school)</td>
<td>Engagement in VPA declined from 70.7% in high school to 47.6% in college (males 73.8% to 52.1%; females 68.1% to 44.0%). The percentage of students who did not engage in any vigorous physical activity over the 7 days increased from 13.2% at high school to 23.2% at college. Among 1st year students the VPA decline from high school was from 73.6% to 54.7% in males and from 66.4% to 46.4% in females. There were differences between genders and between ethnic groups.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Year</th>
<th>Sample Size</th>
<th>Age (Mean)</th>
<th>Follow-up Duration</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler et al. 2004</td>
<td>USA</td>
<td>54 females</td>
<td>5-17.8 years</td>
<td>Transition to university</td>
<td>Upon college entry and 5 months later</td>
<td>- Questionnaire (BQHPA) - The Queens College 3-minute Step Test to estimate VO2 max</td>
<td>Significant decreases were observed in total PA ($P = .05$), occupational activities ($P = .001$), and sport activities ($P = .05$), but there was a significant increase in leisure activities ($P = .05$). Fitness variables showed declines, but they were not significant.</td>
</tr>
<tr>
<td>Brown and Trost 2003</td>
<td>Australia</td>
<td>7281 females</td>
<td>18-23 years</td>
<td>Returning to study (after being at home or after working for a while)</td>
<td>Questionnaires - at baseline: the frequency of participating in “vigorous” and “less vigorous” exercise - at follow-up: hours and minutes spent in walking and moderate and vigorous activity during the previous week</td>
<td>Women were categorized as active (vigorous exercise 3 times/wk, or less vigorous exercise 5 times/wk) or inactive. After adjustment for age, other sociodemographic variables, BMI, and PA at baseline, women who reported returning to study were significantly ($P &lt; 0.009$) more likely to be active at 4-year follow-up than those who did not return to study.</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations:

ALSWH = The Australian Longitudinal Study of Women’s Health (113), BMI = body mass index, BQHPA = The Baecke Questionnaire of Habitual Physical Activity (114), PA = physical activity, SD = standard deviation, USDHHS = US Department of Health and Human Services, VPA = vigorous physical activity
4.5 Change in employment status

Two studies (74), (83) examined the change in physical activity after beginning work or changing work conditions, and two studies (115), (52) examined the change in physical activity after retirement (Table 5). Young women who reported beginning work or changing work conditions during a 4-year study period were significantly more likely to be inactive than those who did not report these events (74). A 17-month follow-up study found no significant differences in changes in physical activity behaviors between maternity leave and returning to work (83).

Retirement during a 6-year follow-up was associated with a significant increase in sport and exercise participation when compared with continuing to work among African-American and white men and women. However, leisure activity declined significantly for both working and retired white women. Among those reporting sport or exercise at baseline, those who retired during the follow-up were more likely to maintain their sport and exercise participation than those who continued to work across ethnicity and gender groups. Among those who reported no sport or exercise at baseline, those who retired were more likely to adopt an activity, except for African-American women (115). A 13-year follow-up study showed, as expected, that retirement was associated with a significantly higher odds for a decline in physical activity from work-related transportation compared with remaining employed. In addition, the study showed no association between retirement and an increase in sports participation or non-sports leisure-time physical activity. However, retirement was associated with a significantly lower odds for a decline in non-sports leisure-time physical activity compared with those who continued to work (52).
### Table 5 Change in employment status and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown and Trost 2003 Australia (74) Longitudinal 4-year follow-up</td>
<td>N = 7281 females Age 18-23 years at baseline (ALSWH)</td>
<td>Beginning work</td>
<td>Questionnaires - at baseline: the frequency of participating in “vigorous” and “less vigorous” exercise - at follow-up: hours and minutes spent in walking and moderate and vigorous activity during the previous week</td>
<td>Women were categorized as active (vigorous exercise 3 times/wk, or less vigorous exercise 5 times/wk) or inactive. After adjustment for age, other sociodemographic variables, BMI, and PA at baseline, women who reported beginning work ($P = 0.004$) or changing work conditions ($P = 0.02$) were significantly more likely to be inactive at 4-year follow-up than those who did not report these events.</td>
</tr>
<tr>
<td>Grace et al. 2006 Canada (83) Prospective observational 17-month follow-up</td>
<td>N = 42 female healthcare workers Age (mean, SD) 32.6 ± 4.2 years</td>
<td>Return to work after maternity leave</td>
<td>Questionnaire (HPLPII) - during pregnancy (on average in their 31st week of pregnancy), during maternity leave (babies’ age on average 9.94 months), after return to work (on average 2.69 months after returning to work)</td>
<td>No significant changes in the mean scores from pregnancy through the postpartum and returning to work were found in the PA behaviors.</td>
</tr>
<tr>
<td>Evenson et al. 2002 USA (115) Longitudinal 6-year follow-up</td>
<td>N = 7 782 3907 males 3875 females Age 45-64 years at baseline 1 825 African-Americans 5 957 Whites</td>
<td>Retirement</td>
<td>Questionnaire (The Baecke) (114) - sport and exercise participation, leisure physical activity and work activity</td>
<td>Participants who retired during the follow-up increased sport + leisure scores significantly across race-gender groups. For those who continued working, the only significant changes in sport + leisure scores were an increase for African-American women. Leisure activity declined significantly for both working and retired white women. Among those who reported sport and exercise at baseline, those who retired were more likely to maintain their sport and exercise participation than those who continued to work across race-gender groups. Among those who were not reporting sport or exercise at baseline, those who retired were more likely to adopt activity than those who continued to work, except for African-American women.</td>
</tr>
</tbody>
</table>

(continued)
| Slingerland et al. 2007 | The Netherlands (52) | Longitudinal 13-year follow-up | N = 971 729 males 242 females Age 40-65 years at baseline (mean, SD) 50.0 ± 5.3 years (The GLOBE study) (116) | Retirement | Questionnaire (SQUASH at follow-up) - work-related transportation, sports participation and non-sport leisure-time PA | Retirement was not associated with an increase in sports participation (OR = 1.12, 95% CI: 0.71, 1.75) or non-sport leisure-time PA (OR = 0.80, 95% CI: 0.54, 1.19). Retirement was associated with significantly lower odds for a decline in non-sport leisure-time physical activity compared with continuing to work (OR = 0.35, 95% CI: 0.19, 0.68). |

Abbreviations:

ALSWH = The Australian Longitudinal Study of Women’s Health (113), BMI = body mass index, CI = confidence interval, HPLPII = The Health-Promoting Lifestyle Profile II (117), MET = metabolic equivalent, OR = odds ratio, PA = physical activity, SD = standard deviation, SQUASH = Short Questionnaire to Assess Health-enhancing Physical Activity (118)
4.6 Marital transitions and changes in relationships

Nine studies (56), (57), (76), (74), (49), (53), (84), (39), (80) examined the change in physical activity after marital transitions or changes in relationships (Table 6). Three longitudinal studies found no significant associations between physical activity and getting married, divorced, separated or widowed (56), (57), (76). However, one of these studies found that individuals who became married during the study period showed a significantly different pattern of physical activity change compared with individuals who remained single throughout the study period (76). One study found that young women who reported getting married were significantly more likely to be inactive at 4-year follow-up than those who did not report getting married. In addition, they found no association between getting divorced and inactivity (74). Another study explored the same data than the previously mentioned study and found that young women who changed from being single to a cohabiting relationship, from single to married, or from cohabiting to married were significantly more likely to decrease their physical activity and remain inactive than those who did not report these life events (49).

Another 4-year follow-up study showed that female nurses who divorced increased their physical activity compared with women who stayed married. In addition, women who were widowed and did not remarry increased their physical activity slightly. However, neither of these changes was statistically significant (53). A longitudinal study showed that divorced and widowed male health professionals who remarried experienced a decrease in physical activity level compared with divorced or widowed male health professionals who remained unmarried (84). Another longitudinal study showed that longer-term widows (1 year or more) statistically significantly increased their level of physical activity compared with women who remained married. In addition, women who remarried statistically significantly decreased their level of physical activity to a greater degree than women who remained married (39). A randomized controlled trial showed that experiencing an interpersonal loss (the death of a spouse, family member, or close friend) was significantly associated with decreased participation in class-based exercise sessions, but not with participation in home-based exercise sessions. This was driven largely by women in the sample because in this study population the number of men experiencing an interpersonal loss was small (80).
Table 6 Marital transitions/changes in relationships and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umberson 1992 USA (56) Longitudinal 3-year follow-up</td>
</tr>
<tr>
<td>Sample (number, gender, age)</td>
</tr>
<tr>
<td>Life event</td>
</tr>
<tr>
<td>Measures</td>
</tr>
<tr>
<td>Results</td>
</tr>
</tbody>
</table>

| Schmitz et al. 1997 USA (57) Longitudinal 2-year follow-up |
| Sample (number, gender, age) | N = 1699 768 males 931 females (The Healthy Worker Project (119)) |
| Life event | Marital status change: becoming married, divorced, separated or widowed |
| Measures | Questionnaire (a modification of the CARDIA questionnaire) |
| Results | Changes in marital status were not associated with changes in physical activity categories. |

<p>| King et al. 1998 USA (76) Longitudinal 10-year follow-up |
| Sample (number, gender, age) | N = 558 256 males 302 females Age 25-75 years (mean, SD) 44.0 ± 15.1 years (The Stanford Five-City Project (120)) |
| Life event | Marital status change: from single to married, from married to single ( = divorced, separated, widowed) |
| Measures | A structured interview - at 5 time points throughout a 10-year period - “How do you rate the physical activity you are now getting compared with others of your sex and age? Think about both your leisure and work activities.” |
| Results | No significant differences among marital state groups were found when the PA means of persons making a marital transition were compared with the means of those remaining in one marital state across the study period. However, the slope analyses showed that individuals who became married during the study period showed a significantly (t (df = 138) = 1.95, P &lt; 0.05) different pattern of PA change (i.e. a decline in the pre-marriage period followed by a relative levelling off in the post-marriage period) compared with individuals who remained single throughout the study period. |</p>
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>N (females)</th>
<th>Age at baseline (mean, SD)</th>
<th>Baseline Characteristics</th>
<th>Follow-up Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown and Trost 2003 Australia (74)</td>
<td>Longitudinal 4-year follow-up</td>
<td>N = 7281 females Age 18-23 years at baseline (ALSWH)</td>
<td>Marriage</td>
<td>Questionnaires - at baseline: the frequency of participating in “vigorous” and “less vigorous” exercise - at follow-up: hours and minutes spent in walking and moderate and vigorous activity during the last week</td>
<td>Women were categorized as active (vigorous exercise 3 times/wk, or less vigorous exercise 5 times/wk) or inactive. After adjustment for age, other sociodemographic variables, BMI, and PA at baseline, women who reported getting married were significantly (P &lt; 0.0001) more likely to be inactive at 4-year follow-up than those who did not report getting married. Getting divorced during the 4-year follow-up was not associated with decreased PA.</td>
<td></td>
</tr>
<tr>
<td>Bell and Lee 2005 Australia (49)</td>
<td>Longitudinal 4-year follow-up</td>
<td>N = 8545 females Age 18-23 years (mean, SD) 20.7 ± 1.48 years at baseline (ALSWH)</td>
<td>Cohabiting relationship</td>
<td>Marriage</td>
<td>Questionnaires - at baseline: the frequency of participating in “vigorous” and “less vigorous” exercise - at follow-up: hours and minutes spent in walking and moderate and vigorous activity during the last week</td>
<td>Women were categorized as active (vigorous exercise 3 times/wk, or less vigorous exercise 5 times/wk) or inactive. In comparison with remaining single, moving into a cohabiting relationship was associated with a greater likelihood of decreasing PA, whereas changing from single to married was associated with a greater likelihood of decreasing activity or remaining inactive and with a lower likelihood of remaining active or increasing activity. Also, those who made a transition from cohabiting to marriage were significantly more likely to decrease activity or remain inactive and significantly less likely to remain active.</td>
</tr>
<tr>
<td>Lee et al. 2005 USA (53)</td>
<td>Longitudinal 4-year follow-up</td>
<td>N = 80 944 females Age 46-71 years</td>
<td>Marital transitions: married to divorced, married to widowed, unmarried to married</td>
<td>Questionnaire</td>
<td>Women who divorced increased PA by 1.23 MET-h/wk (P = 0.07) compared with women who stayed married. Women who were widowed and remained unmarried increased their PA slightly, but the change was not statistically significant.</td>
<td></td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Design/Methodology</th>
<th>Sample Size</th>
<th>Age at Baseline</th>
<th>Marital Transitions</th>
<th>Questionnaire</th>
<th>Physical Activity Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng et al. 2005 USA</td>
<td>Prospective longitudinal design 1986-1994</td>
<td>N = 38,865 males</td>
<td>Age 40-75 years at baseline</td>
<td>Married to divorced, married to widowed, remarriage</td>
<td>Questionnaire at least two time points spaced 4 years apart</td>
<td>Divorced and widowed men who remarried had decreased levels of PA (-2.00 METs/wk, P = 0.027) compared with divorced or widowed men who remained unmarried.</td>
</tr>
<tr>
<td>Wilcox et al. 2003 USA</td>
<td>Longitudinal 3-year follow-up</td>
<td>N = 55,724 females</td>
<td>Age 50-79 years (mean, SD) 64.09 ± 7.32 years</td>
<td>Widowhood</td>
<td>Questionnaire</td>
<td>Longer-term widows (1 year or more) increased their level of PA compared with women who remained married (P = 0.03). Women who remarried decreased their level of PA to a greater degree than women who remained married (P &lt; 0.01).</td>
</tr>
<tr>
<td>Wilcox and King 2004 USA</td>
<td>1-year RCT</td>
<td>N = 97 females</td>
<td>Age (mean, SD) 70.2 ± 4.1 years</td>
<td>Interpersonal loss: death of a spouse, family member or close friend</td>
<td>Life events: Questionnaire from the SRRS PA: Participation in exercise groups (moderate-intensity endurance and strengthening, stretching and flexibility) Self-reported exercise logs (validated with heart rate and activity monitor) Clinical evaluations</td>
<td>Experiencing an interpersonal loss was not associated with participation in home-based exercise sessions, but it was negatively associated with participation in class-based exercise sessions. Of those who reported an interpersonal loss, 62.7% ± 28.5% participated compared with 72.3% ± 23.8% of those who did not (t (94) = 1.70, P &lt; 0.05).</td>
</tr>
</tbody>
</table>

**Abbreviations:**

ALSWH = The Australian Longitudinal Study of Women’s Health (113), BMI = body mass index, CARDIA = The Coronary Artery Risk Development in Young Adults (121), h = hour, MET = metabolic equivalent, PA = physical activity, RCT = randomized controlled trial, SD = standard deviation, SRRS = The Social Readjustment Scale (31), wk = week
4.7 Pregnancy and the postpartum period

Six studies (85), (86), (38), (87), (88), (74) examined the change in physical activity from prepregnancy to postpartum (Table 7). A cross-sectional retrospective study showed that women’s strenuous, moderate and mild exercise behavior (frequency and intensity of physical activity) was significantly higher pre-pregnancy than during pregnancy and postpartum. No significant differences were found in women’s exercise behavior during pregnancy and postpartum (data collected between 6 days to 5 months following the birth of a baby) (85). Another cross-sectional retrospective study showed that a significantly larger percentage of women were active before pregnancy but inactive or irregularly active after childbirth in a multiethnic sample of women. There were no differences between ethnic groups (86). In contrast, one cross-sectional retrospective study found no differences between the pre-pregnancy and postpartum activity in sports/exercise and active living habits (38).

One longitudinal study found a decrease in the mean total leisure physical activity from before pregnancy to during the second trimester of pregnancy. A partial rebound occurred at 6 months postpartum. Walking decreased slightly from pre-pregnancy to the second trimester, but rebounded to the pre-pregnancy level at 6 months postpartum. The percentage of women who were insufficiently active for health increased from 12.6% before pregnancy to 21.6% during pregnancy and remained at 21.7% during the postpartum period (87). Another longitudinal study showed that an estimate of total monthly METs did not differ significantly between the prepartum and postpartum time intervals. However, specific activities differed. Conditioning and occupational activities decreased significantly postpartum, whereas walking and home activities increased. There were statistically significant decreases in both maximal oxygen consumption and leg strength from prepregnancy to 6 week postpartum, with some of these decreases recovering by 27 week postpartum (88). One study found that women who reported giving birth to a first or subsequent child were significantly more likely to be inactive at 4-year follow-up than those who did not report these events (74).
Table 7 Pregnancy/postpartum period and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symons Downs and Hausenblas 2004 USA (85)</td>
<td>N = 74 women Age 19-40 years (mean, SD) 31.30 ± 4.37 years</td>
<td>Pregnancy</td>
<td>Questionnaire (GLTEQ)</td>
<td>Women’s pre-pregnancy strenuous exercise was higher than their pregnancy and postpartum exercise, ( L(3) = 19.44, P &lt; 0.001, \eta^2 = .54 ). Women’s pre-pregnancy moderate exercise was higher than their pregnancy and postpartum exercise, ( L(3) = 14.25, P &lt; 0.01, \eta^2 = .41 ). Pre-pregnancy mild exercise was higher than pregnancy and postpartum exercise, ( L(3) = 10.64, P &lt; 0.05 \eta^2 = .32 ). There were no significant differences in women’s mild, moderate, and strenuous exercise behaviour in pregnancy and postpartum (( P &gt; 0.05 )).</td>
</tr>
<tr>
<td>Albright et al. 2005 Hawaii (86)</td>
<td>N = 79 women Age (mean, SD) 31.8 ± 5.5 years 29 Whites 30 Asians 11 Hawaiian or Pacific Islanders 9 others</td>
<td>Postpartum</td>
<td>Questionnaire - Group discussion - Data collected when infants’ mean age was 8.2 ± 3.8 months - Retrospective pre-pregnancy PA</td>
<td>21.5% were inactive before and after childbirth, 22.7% were active before and after, 12.6% were inactive before but active after childbirth, and 43.0% were active before but inactive or irregularly active postpartum (( P &lt; 0.0003 )). For those who reduced their PA following childbirth, the mean number of days reduced per week was 1 ± 3.2. There were no differences between ethnic groups.</td>
</tr>
<tr>
<td>Blum et al. 2004 USA (38)</td>
<td>N = 91 women Age (mean, SD) 28.6 ± 4.7 years</td>
<td>Postpartum</td>
<td>Questionnaire (KPAS) - PA from pre-pregnancy postpartum</td>
<td>No differences between the pre-pregnancy and postpartum KPAS activity indexes of SE (sports/exercise) and AL (active living habits) for all subjects (( P &gt; 0.05 )). Subjects with infants ≥ 6 months reported greater increase in HC (household/care giving) activities (0.29 ± 0.45 vs. 0.04 ± 0.45; ( P &lt; 0.05 )) and lower O (occupation) index (0.49 ± 1.4 vs. 1.33 ± 1.4, ( P &lt; 0.05 )) from pre-pregnancy to postpartum compared with subjects with infants &lt; 6 months. Subject with no other children significantly increased HC (0.32 ± 0.57 vs. 0.02 ± 0.34; ( P &lt; 0.05 )) and decreased O (1.5 ± 1.6 vs. 0.67 ± 1.3, ( P &lt; 0.05 )) compared with subjects with ≥ 1 other child.</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Duration</td>
<td>Participants</td>
<td>Methods</td>
</tr>
<tr>
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</tr>
<tr>
<td>Pereira et al. 2007</td>
<td>USA (87)</td>
<td>Longitudinal 18-month follow-up (Retrospective pre-pregnancy PA)</td>
<td>N = 1242 women Age (mean, SD) 32.5 ± 4.5 years</td>
<td>Pregnancy Postpartum A modification of the leisure-time activity section of the PASE - Questionnaire at three time points (during first trimester, second trimester, and at 6 months postpartum)</td>
</tr>
<tr>
<td>Treuth et al. 2005</td>
<td>USA (88)</td>
<td>Longitudinal 19-month follow-up</td>
<td>N = 63 women Age 18-40 years (mean ± SD) 30.7 ± 4.1 years</td>
<td>Postpartum - Questionnaire (a version of the Taylor Questionnaire for the Assessment of Leisure Time Physical Activities (122)) - Cycle ergometer (VO2 max) - One-repetition maximum tests - Measures before pregnancy, at 6 and at 27 wk postpartum</td>
</tr>
<tr>
<td>Brown and Trost 2003</td>
<td>Australia (74)</td>
<td>Longitudinal 4-year follow-up</td>
<td>N = 7281 women Age 18-23 years at baseline (ALSWH)</td>
<td>Giving birth to a first or subsequent child Questionnaires - at baseline: the frequency of participating in “vigorous” and “less vigorous” exercise - at follow-up: hours and minutes spent in walking and moderate and vigorous activity during the previous week</td>
</tr>
</tbody>
</table>

Abbreviations:

ALSWH = The Australian Longitudinal Study of Women’s Health (113), BMI = body mass index, CI = confidence interval, h = hour, KPAS = Kaiser Physical Activity Survey (123), MET = metabolic equivalent, PA = physical activity, PASE = Physical Activity Scale for the Elderly (124), GLTEQ = The Godin Leisure-Time Exercise Questionnaire (125), SD = standard deviation, VO2 max = maximal oxygen uptake, wk = week
4.8 Mass urban disaster or onset of chronic medical condition

One study (89) examined the change in physical activity after a mass urban disaster, and one study (57) examined the change in physical activity after an onset of a chronic medical condition (Table 8). The first one found that in the days after the terrorist attacks on September 11, 2001, 33% of the New York metropolitan area residents who participated in the study were exercising less. As expected, people who had been present at the World Trade Center during the attacks were more likely to be exercising less than usual than those who had not been there. At 4-month follow-up, 13% of the participants who had decreased their exercise behavior after the event had still not returned to their baseline exercise habits (89).

In the other study no significant association was found between the self-reported onset of a chronic medical condition (diabetes, high blood pressure, chronic lung disease; asthma, emphysema, or chronic bronchitis, or a heart attack for which they had been hospitalized for a week or more) and change in physical activity categories during a 2-year follow-up (57).
Table 8 Mass urban disaster or onset of chronic medical condition and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho et al. 2002 USA (89)</td>
<td>N = 244 New Yorkers 110 males 134 females Age (mean, SD) men: 46 ± 11 years, women: 47 ± 13 years</td>
<td>The terrorist attacks against the United States on September 11, 2001</td>
<td>Interview - within 3 weeks of the terrorist attacks - a follow-up 4 months later Exercise: “more”, “less”, or “unchanged” since the terrorist attacks</td>
<td>33% of the participants were exercising less in the days following the event and only 1% were exercising more. People who had been present at the World Trade Center were 1.5 times more likely to be exercising less ($P = 0.007$) than usual than those not present at the World Trade Center. At 4-month follow-up, 13% of the persons who experienced initial changes had not returned to baseline exercise habits.</td>
</tr>
<tr>
<td>Schmitz et al. 1997 USA (57)</td>
<td>N = 1699 768 males 931 females (The Healthy Worker Project)</td>
<td>Chronic medical condition</td>
<td>- PA: a modification of the CARDIA questionnaire - Chronic medical condition: Subjects were asked if they had ever been told by a doctor or other medical person that they had diabetes, high blood pressure, or chronic lung disease (asthma, emphysema, or chronic bronchitis) or had ever had a heart attack for which they were hospitalized for a week or more</td>
<td>There was no association between onset of chronic medical condition during the follow-up and change in physical activity categories.</td>
</tr>
</tbody>
</table>

Abbreviations:

CARDIA = The Coronary Artery Risk Development in Young Adults (126), PA = physical activity, SD = standard deviation
4.9 Cancer

4.9.1 Datasets including several types of cancer

Six studies (90), (77), (91), (92), (93), (94) examined the effect of cancer diagnosis on physical activity in a sample of adult multiple cancer survivors, and two studies (40), (95) examined the effect of cancer diagnosis on physical activity in a sample of adolescent multiple cancer survivors (Table 9). A cross-sectional retrospective study which examined physical exercise in cancer patients receiving high dose chemotherapy (HDC) and autologous bone marrow transplantation (BMT) showed significant reductions in mild, moderate and strenuous intensity exercise from pre-diagnosis to post-diagnosis (before HDC/BMT procedure) (90).

In a cross-sectional study, mixed-cancer survivors (breast, colorectal, lung, prostate, non-Hodgkin’s lymphoma) were asked if they had changed the amount they exercise since they were diagnosed with cancer (mean time since diagnosis was 2.3 years when the data were collected): 16% of the participants answered that they exercised more since the diagnosis, 53% exercised the same amount, and 31% exercised less (127). In another cross-sectional study, cancer survivors were also asked if they had changed their physical activity since the diagnosis (time since diagnosis was more than 2 years with most of the participants): 31.3% reported an increase in physical activity, 62.5% reported no change, and 6.2% reported a decreased physical activity level after cancer diagnosis. Changes in physical activity did not differ between individuals with a cancer diagnosis and their family and friends (91).

One cross-sectional study found that in the past 12 months, 20.8% of the mixed-cancer survivors had begun a new physical activity which was aimed at coping with cancer or reducing the risk of cancer spreading or returning. Patients receiving three or more medical treatments were two or three times more likely to start a new physical activity compared with patients receiving only one medical treatment. Patients diagnosed 12 to 24 months in the past were equally as likely to report making lifestyle changes as those diagnosed less than 12 months earlier (92). One cross-sectional study found that 13.7% of cancer patients added a new physical activity, and that there was no difference in the change in physical activity between those who were aware of the diagnosis and those who were not informed about their diagnosis of cancer by their doctor. Older patients (> 65 years) were significantly less likely to add a new physical activity than younger ones (93). Another cross-sectional study showed
that less than 10% of veterans with cancer reported that their exercise level had increased since a cancer diagnosis, and 43% reported that their exercise level had decreased (94).

In a study of adolescent mixed-cancer survivors (mean age 17.3 years), 81.1% of the participants were active before diagnosis, 32.1% during treatment, and 71.4% post-treatment. The adolescents exhibited four main physical activity patterns across the cancer experience (pre-diagnosis, during treatment, and post-treatment); 27% were labeled as maintainers, 39% as temporary relapsers, 12% as permanent relapsers, and 12% as nonparticipants. Very few adolescents who were inactive before diagnosis became active either during or following treatment (40). Another cross-sectional study with a retrospective questionnaire found a decrease in the total physical activity from pre-diagnosis to during the treatment among adolescent cancer survivors (mean age 17.3 years). Also, the frequency of both moderate and vigorous physical activity remained substantially reduced following treatment completion when compared with pre-diagnosis levels. According to the results, 84.5% of the participants were active before diagnosis, 26.4% during treatment, and 73.6% after treatment. Altogether 23% of the participants were labeled maintainers, 47.1% temporary relapsers, 13.8% permanent relapsers, and 10.3% nonparticipants. Less than 5% of those who were inactive before diagnosis became active after treatment (95).
Table 9 Cancer and change in physical activity (datasets including several types of cancer)

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courneya et al. 2000 Canada (90) Prospective observational (Retrospective pre-diagnosis PA)</td>
<td>N = 25 52% male Age 24-70 years (mean, SD) 47.16 ± 12.09 years Baseline questionnaire after diagnosis, but before BMT</td>
<td>Cancer (breast 36%, non-Hodgkin’s lymphoma 23%, multiple myeloma 23%, Hodgkin’s disease 9%, other 9%) - patients who received HDC followed by autologous BMT</td>
<td>Questionnaire (LSI of GLTEQ) - recall of past exercise (pre-diagnosis: the months prior to diagnosis, and post-diagnosis: the months between diagnosis and the HDC/BMT procedure) Exercise log - during hospitalization - walking + computerized cycle ergometer</td>
<td>Results indicated significant reductions in the weekly frequency of mild ( t(24) = 2.51, P &lt; 0.001, ) one-tailed, moderate ( t(24) = 1.84, P &lt; 0.04, ) one-tailed, and strenuous ( t(24) = 1.74, P &lt; 0.05, ) one-tailed exercise from pre-diagnosis to post-diagnosis (before BMT). The absolute levels of exercise after BMT were very low; 40% reported no cycling at all, 24% reported no cycling or walking, and the mean combined cycling/walking duration for participants was less than 8 min/day.</td>
</tr>
<tr>
<td>Blanchard et al. 2003 USA (127) Cross-sectional</td>
<td>N = 352 71% females Age (mean, SD) 59.6 ± 12.70 years Mean time since diagnosis 2.26 years (SD 3.21 years)</td>
<td>Cancer (breast 49.1%, colorectal 10.8%, lung 9.7%, prostate 9.7%, non-Hodgkin’s lymphoma 7.7%)</td>
<td>Questionnaire: “Has the amount you exercise changed since you were diagnosed with cancer?”</td>
<td>16% of the participants indicated that they exercised more since cancer diagnosis, 53% exercised the same amount, and 31% exercised less. 57% of the participants currently exercised 3 times/wk for at least 30 min each time. Of these participants, 23% had increased their exercise since cancer diagnosis, 51% exercised the same amount, and 25% exercised less. Of the participants who did not currently exercise 3 times/wk, 6% exercised more since cancer diagnosis, 55% exercised the same amount, and 39% exercised less.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Sample Size</th>
<th>Gender Distribution</th>
<th>Age Range</th>
<th>Time since diagnosis</th>
<th>Cancer Type</th>
<th>Data Collection Method</th>
<th>Physical Activity Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpel et al. 2007</td>
<td>Australia (91)</td>
<td>N = 657</td>
<td>81.4% female</td>
<td>46 ± 15 years</td>
<td>71.2%</td>
<td>Cancer (breast 41.6%, melanoma 14.9%, cervical 10.9%, colon/rectal 6.9%, ovarian 5.9%, other 16%)</td>
<td>Questionnaire</td>
<td>The average total PA amount for the whole sample was 380 (SD = 343) min/wk. For cancer survivors, 31.3% reported an increase in physical activity, 62.5% no change, and 6.2% a decreased physical activity level. For individuals with a friend or relative diagnosed with cancer, 24.3% reported an increase in physical activity. The PA levels or changes in PA did not differ significantly between individuals with and without a cancer diagnosis.</td>
</tr>
<tr>
<td>Patterson et al. 2003</td>
<td>USA (92)</td>
<td>N = 356</td>
<td>Half female</td>
<td>62.5 ± 10.7 years</td>
<td>51% diagnosed within the previous 11 months, 49% 12 to 24 months before sampling</td>
<td>Cancer (breast n = 126, prostate n = 114, colorectal n = 116)</td>
<td>Telephone interview</td>
<td>20.8% of the participants began a new PA in the past 12 months. 82.4% of these participants began an aerobic exercise and 21.6% began qi gong, thai chi, yoga or some other kind of exercise. Patients receiving three or more medical treatments were two or three times more likely to start a new PA compared with patients receiving only one medical treatment (P for trend ≤ 0.05). Patients diagnosed 12 to 24 months in the past were equally as likely to report making lifestyle changes as those diagnosed less than 12 months earlier.</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Type</td>
<td>Sample Size</td>
<td>Gender Distribution</td>
<td>Age (mean, SD)</td>
<td>Diagnosis Mean Duration</td>
<td>Cancer Types</td>
<td>Data Collection Method</td>
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<tr>
<td>Kostopoulou and Katsouyanni</td>
<td>Greece</td>
<td>Cross-sectional</td>
<td>N = 124</td>
<td>55% female</td>
<td>62.3 ± 12.4 years</td>
<td>Diagnosed 6-24 months before sampling</td>
<td>Breast cancer n = 50, prostate cancer n = 24, colorectal cancer n = 50</td>
<td>Personal interview</td>
</tr>
<tr>
<td>Jazieh et al. 2006</td>
<td>USA</td>
<td>Cross-sectional</td>
<td>N = 200</td>
<td>98% males</td>
<td>Age 36-87 years, median age 68</td>
<td>Veterans with the diagnosis of malignancy</td>
<td>Cancer (malignancy: genitourinary 39.5%, lung 19.5%, gastrointestinal 14.5%, hematologic 16%, skin, head and neck 6.5%, others 4%)</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Keats et al. 1999</td>
<td>Canada</td>
<td>Cross-sectional retrospective</td>
<td>N = 49</td>
<td>53% boys</td>
<td>Age 17.3 ± 1.65 years</td>
<td>The mean number of months since diagnosis 33.1 (SD = 18.9)</td>
<td>Cancer (lymphoma or Hodgkin's disease 32.1%, leukemia 22.6%, tumors of the central nervous system 15.1%)</td>
<td>Questionnaire (LSI of GLTEQ)</td>
</tr>
</tbody>
</table>

(continued)
| Keats et al. 2006 Canada (95) | N = 97 57% males 17.3 ± 1.2 years (mean, SD)  Number of months since diagnosis 3-92 (mean, SD) 32.1 ± 23.5 months | Cancer (Hodgkin’s disease 29.9%, leukemia 27.8%, tumors of the central nervous system 14.4%, osteosarcoma 8.2%, ovarian/testicular 4.1%, other 15.5, %) | Questionnaire (LSI of GLTEQ) - Participants were asked to recall their physical activity behaviors at 3 time periods: (1) pre-diagnosis, (2) during treatment, and (3) post-treatment. Significant differences emerged for all 3 intensity levels (strenuous, moderate, and mild) and total LTPA. Specifically, there was a statistically significant decrease in the total LTPA from pre-diagnosis (mean = 57.5; SD = 32.8) to during treatment (mean = 17.6; SD = 19.6), $t(86) = 12.6, P < 0.0005$. Also, pre-diagnosis levels of PA were not regained following treatment completion (mean = 46.9; SD = 29.4), $t(86) = 3.2, P = 0.002$. The frequency of vigorous ($P = 0.001$) and moderate activity ($P = 0.052$) remained decreased following treatment. 84.5% were active (at least 27 METs/wk) pre-diagnosis, 26.4% were active during treatment, and 73.6% were active post-treatment. 94.3% fell into 4 main activity patterns; maintainers (23%), temporary relapsers (47.1%), permanent relapsers (13.8%), and nonparticipants (10.3%). Less than 5% of those who were inactive pre-diagnosis became active post-treatment. |

**Abbreviations:**  
BMT = bone marrow transplantation, HDC = high dose chemotherapy, LSI of GLTEQ = Leisure Score Index of the Godin Leisure Time Exercise Questionnaire (128), (125), LTPA = leisure time physical activity, MET = metabolic equivalent, min = minutes, PA = physical activity, SD = standard deviation, wk = week
4.9.2 Breast cancer

Seven studies (96), (97), (98), (99), (100), (101), (102) examined the change in physical activity after breast cancer diagnosis (Table 10). A cross-sectional retrospective study of breast cancer survivors revealed five main exercise patterns across the cancer “experience” (pre-diagnosis, during treatment, and post-treatment); 13% of the participants were maintainers, 19% temporary relapsers, 9% permanent relapsers, 43% non-exercisers, and 9% adopters (96). Another retrospective study found that exercise behavior was significantly lower both during active treatment and post-treatment than pre-diagnosis, and during active treatment than post-treatment (97).

One study showed that in patients with breast carcinoma there was a statistically significant decrease in time spent in total physical activity from the year pre-diagnosis to within 1 year post-diagnosis. Statistically significantly greater decreases in sports physical activity were observed among women who were treated with radiation and chemotherapy compared with women who underwent surgery only or who were treated with radiation only (98). A prospective analysis showed that the mean physical activity levels in breast cancer patients at 24 months post-diagnosis were only slightly lower from the mean pre-diagnosis values. Most participants reported maintaining or decreasing their moderate to vigorous and their vigorous activity levels across the cancer experience. Sixty-five percent of participants reported increasing their household activity levels across the cancer experience. The mean of sports and recreation activity decreased from pre-diagnosis to post-diagnosis, and 63% of women reported maintaining or decreasing their sports and recreation activity across the cancer experience (99).

Another prospective study showed that 175 out of 868 participants were categorized as inactive (before and after diagnosis), 153 had decreased their activity, 163 maintained their activity, and 195 increased their activity (100). One study found a significant decrease in physical activity from before diagnosis to 1 year post-diagnosis among pre-menopausal breast cancer patients receiving adjuvant chemotherapy (101). Another study found that 50% of the breast cancer patients receiving usual care reported maintaining or increasing their physical activity to a moderate-intensity level, while 33% of the exercise group (usual care plus home-based brisk walking intervention) did not exercise at the prescribed levels. The results suggest that women who exercised regularly before the breast cancer diagnosis attempted to maintain their exercise programs (102).
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhodes et al. 2001</td>
<td>N = 175 women</td>
<td>Breast cancer (non-metastatic)</td>
<td>Questionnaire</td>
<td>Five main exercise patterns; 13% of the participants were maintainers (active at all three time periods), 19% temporary relapsers (active pre-diagnosis, inactive during treatment, active post-treatment), 9% permanent relapsers (active pre-diagnosis, inactive during treatment, inactive post-treatment), 43% non-exercisers (inactive at all time periods) and 9% adopters (inactive pre-diagnosis, inactive during treatment, active post-treatment).</td>
</tr>
<tr>
<td>Canada (96)</td>
<td>Age (mean, SD) 52.3 ± 9.4 years</td>
<td>80.3% had had a mastectomy, 45.5% received both CT and RT</td>
<td>Exercise stage recalled for 3 time periods (pre-diagnosis, during treatment, and post-treatment)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean number of months since diagnosis 20.2 (SD = 3.5 months)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Valenti et al. 2008</td>
<td>N = 212 women</td>
<td>Breast cancer</td>
<td>Questionnaire (LSI of GLTEQ)</td>
<td>Significant differences across the cancer-relevant time-periods for all exercise behavior outcomes (the average frequency of total, mild, moderate and strenuous intensity exercise during free time in a week) (P &lt; 0.001, F = 5.16). The exercise behavior outcomes were significantly lower during both on-treatment and off-treatment than pre-diagnosis, and exercise during active treatment was significantly lower than during off-treatment.</td>
</tr>
<tr>
<td>Italy (97)</td>
<td>Age 42-65 years (mean, SD) 55.1 ± 6.2 years</td>
<td>- Recall of exercise for three time periods (pre-diagnosis, during active treatment, off-treatment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean time since diagnosis 2.6 years (SD 0.9 years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Participants</td>
<td>Disease</td>
<td>Methods</td>
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<tr>
<td>Irwin et al. 2003 USA (98)</td>
<td>Retrospective population-based cohort study</td>
<td>N = 812 women (HEAL study) Age (mean, SE) 52.4 ± 6.4 years (Washington) 59.2 ± 12.6 years (New Mexico) 4–12 months post-diagnosis</td>
<td>Breast carcinoma</td>
<td>The interview-administered Modifiable Activity Questionnaire developed by Kriska (129) - Participants recalled PA for the year before diagnosis and for the month before the interview, corresponding to the period 4–12 months post-diagnosis</td>
</tr>
<tr>
<td>Alfano et al. 2007 USA (99)</td>
<td>Prospective 2 year follow-up (Retrospective pre-diagnosis PA)</td>
<td>N = 545 women (HEAL study participants) Age 29-86 (mean, SD) 58.0 ± 10.3 years On average 6 months post-diagnosis</td>
<td>Breast cancer</td>
<td>The interview-administered Modifiable Activity Questionnaire developed by Kriska (129) - 6 months post-diagnosis in person or by mail: retrospective reports of pre-diagnosis PA - at 29 months post-diagnosis (post-diagnosis PA)</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Age Range</th>
<th>Baseline Measurement</th>
<th>Follow-up Measurement</th>
<th>Baseline Activity</th>
<th>Follow-up Activity</th>
<th>Change in PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irwin et al. 2008 USA (100)</td>
<td>686</td>
<td>27-54</td>
<td>6 ± 2 months</td>
<td>6 ± 2 months</td>
<td>Breast cancer</td>
<td>Change in PA: 175 were inactive = 0 MET-h/wk before and after diagnosis, 153 decreased their PA = &lt; -3 MET-h/wk (mean ± SD = -18.1 ± 16.6 MET-h/wk), 163 maintained their PA = ± 3 MET-h/wk (mean ± SD = 0.0 ± 2.4 MET-h/wk), and 195 increased their PA = &gt; 3 MET-h/wk (mean ± SD = 18.3 ± 16.7 MET-h/wk).</td>
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<tr>
<td>Prospective observational 5-8 year follow-up (Retrospective pre-diagnosis PA)</td>
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<tr>
<td>Demark-Wahnefried et al. 2001 USA (101)</td>
<td>53</td>
<td>27-54</td>
<td>Baseline within 3 weeks of diagnosis, follow-up 1 year post-diagnosis</td>
<td>Breast cancer Pre-menopausal patients receiving adjuvant CT</td>
<td>Stanford Five-City Project Questionnaire (130) - at baseline (within 3 weeks of diagnosis): estimation of usual level of activity before diagnosis - average activity level throughout 1 year post-diagnosis</td>
<td>Significant decrease in physical activity from baseline to 1 year post-diagnosis (P = .01).</td>
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</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Author</th>
<th>Year, Country</th>
<th>Design</th>
<th>Sample Size</th>
<th>Age Range</th>
<th>Diagnosis</th>
<th>Treatment</th>
<th>Activity Level Rating Scale</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickett et al.</td>
<td>2002, USA (102)</td>
<td>Prospective RCT (Retrospective pre-diagnosis PA)</td>
<td>N = 48 women</td>
<td>Age 28-75 years (mean, SD) 48 ± 11.4 years</td>
<td>Breast cancer</td>
<td>The activity level rating scale</td>
<td>52% of the usual-care group engaged in moderate intensity or higher levels of exercise at some point during the study, 40% reported high levels of exercise during the study period, and six of these women reported maintaining a high level of exercise through the end point of the study. 33% of the exercise group did not exercise at the prescribed levels, 22% of the exercise group never initiated the brisk walking program, and 13% stopped the walking program at least 1 month before the study ended.</td>
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</table>

**Abbreviations:**
- CT = chemotherapy, h = hour, HEAL = The Health, Eating, Activity, and Lifestyle Study (131), LSI of GLTEQ = Leisure Score Index of the Godin Leisure Time Exercise Questionnaire (128), (125), MET = metabolic equivalent, min = minutes, PA = physical activity, RCT = randomized controlled trial, RT = radiotherapy, SD = standard deviation, SE = standard error, wk = week
4.9.3 Colorectal cancer

Five studies (78), (103), (79), (104), (105) examined the change in physical activity after colorectal cancer diagnosis (Table 11). A retrospective study showed that in colorectal cancer survivors there was a significant decrease in moderate, strenuous, and total exercise from pre-diagnosis to active treatment, and a significant increase in these same exercise parameters from active treatment to post-treatment. However, the post-treatment levels did not return to pre-diagnosis levels. The results show four major exercise patterns across the cancer experience; maintainers (31% of the participants), temporary relapsers (16%), permanent relapsers (14%), and non-exercisers (30%) (78). Another retrospective study showed a statistically significant decrease in the proportion of participants meeting the physical activity guidelines from pre-diagnosis to post-diagnosis across all age and gender categories. Fifty-three percent of participants (55% of men and 51% of women) were categorized as sufficiently active before the diagnosis, whereas 32% (36% of men and 28% of women) achieved these amounts of physical activity after the diagnosis (103).

One retrospective study showed that colon cancer survivors reported statistically significant increases in non-occupational weekly physical activity from pre-diagnosis to post-diagnosis. However, the non-cancer control group also increased their levels of physical activity, and there was no statistically significant difference for the amount or degree of change in physical activity between the cancer survivors and the controls (79). Another retrospective study showed that moderate-plus-strenuous exercise declined significantly from pre-diagnosis to during treatment, and increased significantly from during treatment to post-treatment, returning to pre-diagnosis levels. Also, the percentage of participants meeting exercise guidelines declined from pre-diagnosis (24.7%) to during treatment (8.7%), and increased from during treatment to post-treatment (25.9%), returning to pre-diagnosis levels (104).

A longitudinal study found that more than 50% of female colorectal cancer survivors changed their levels of recreational physical activity from pre-diagnosis (median 6 months before diagnosis) to between 1 and 4 years post-diagnosis. Altogether 144 out of 523 participants increased their activity level, 176 decreased their activity level, and 203 did not change their activity level (105).
### Table 11 Colorectal cancer and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courneya and Friedenreich 1997 Canada (78) Retrospective</td>
<td>N = 130 84 males 46 females Age 26-81 years (mean, SD) 62.1 ± 10.6 years Months since diagnosis 9-51 (median, SD) 27.2 ± 12.3 months</td>
<td>Colorectal cancer</td>
<td>Questionnaire (LSI of GLTEQ) - Exercise behaviour from pre-diagnosis, active treatment and post-treatment</td>
<td>Moderate exercise decreased from pre-diagnosis to active treatment, ( t(129) = 6.00, P &lt; 0.001 ), then increased from active treatment to post-treatment, ( t(129) = 4.46, P &lt; 0.001 ), but not back to pre-diagnosis levels, ( t(129) = 2.41, P &lt; 0.071 ). Strenuous exercise decreased from pre-diagnosis to active treatment, ( t(129) = 4.84, P &lt; 0.001 ), then increased from active treatment to post-treatment ( t(129) = 4.34, P &lt; 0.001 ), but not back to pre-diagnosis levels. Total exercise likewise decreased from pre-diagnosis to active treatment, ( t(129) = 7.35, P &lt; 0.001 ), then increased from active treatment to post-treatment, ( t(129) = 5.92, P &lt; 0.001 ), but not back to pre-diagnosis levels, ( t(129) = 2.97, P &lt; 0.004 ). Four major patterns of exercise emerged: maintainers (31% of the participants), temporary relapsers (16%), permanent relapsers (14%), and nonexercisers (30%).</td>
</tr>
<tr>
<td>Lynch et al. 2007 Australia (103) Retrospective</td>
<td>N = 1996 1176 males (60%) 790 females (40%) Age groups 20-49 years 9% 50-59 years 19% 60-69 years 34% 70-80 years 38% Months since diagnosis (mean, SD) = 4.5 ± 1.5 months</td>
<td>Colorectal cancer</td>
<td>Telephone interview - The amount of time in walking for transport or recreation; in other moderate-intensity PA; and in vigorous intensity PA - In an average week over the past month and in an average week, during the year preceding the diagnosis</td>
<td>Before the diagnosis, 53% of the participants (55% of men; 51% of women) were categorized as sufficiently active (at least 150 min of moderate-intensity activity or 90 min of vigorous-intensity activity per wk, or an equivalent combination of moderate and vigorous activity). After the diagnosis, 32% of the participants (36% men and 28% women) achieved 150 min of PA per week. The decrease in the proportion of participants meeting the physical activity guidelines was statistically significant across all age and gender categories ( P &lt; 0.01 ). There were no significant differences in time from diagnosis between physical activity categories ( F = 0.34, P = 0.56 ).</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Sample Size</th>
<th>Participants</th>
<th>Outcome</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satia et al.</td>
<td>2004</td>
<td>USA</td>
<td>N = 278 cases</td>
<td>Age (mean, SD) 65.4 ± 10.4 years, 52.9% males, 60.8% white, 39.2% African American</td>
<td>Colorectal cancer</td>
<td>A modified version of a Seven-Day Physical Activity Recall (132) Face-to-face interview (NCCCS) Telephone interview (NC STRIDES)</td>
<td>Statistically significant increases in non-occupational weekly PA from pre-diagnosis (mean 179, SD 37 METs) to post-diagnosis (mean 228, SD 47 METs) ($P &lt; 0.0001$). Controls also increased their PA ($P &lt; 0.0001$). There was no statistically significant difference for amount or degree of change between cases and controls. The findings did not differ significantly by race.</td>
</tr>
<tr>
<td>Peddle et al.</td>
<td>2008</td>
<td>Canada</td>
<td>N = 413</td>
<td>225 male (54.5%), 188 female (45.5%)</td>
<td>Colorectal cancer (colon 318, rectal 95)</td>
<td>Questionnaire (LSI of GLTEQ) - Exercise in a typical week during three separate time periods: before diagnosis, during any adjuvant therapy and during the past month.</td>
<td>Minutes of moderate-plus-strenuous exercise declined significantly from pre-diagnosis to during treatment (mean group difference, 61 min; 95% CI, 49-72; $P &lt; 0.001$) and significantly increased from during treatment to post-treatment (mean group difference, 58; 95% CI, 46-69; $P &lt; 0.001$), returning to pre-diagnosis levels (mean group difference, 3; 95% CI, -8 to 14; $P = 0.601$). The percentage of participants meeting exercise guidelines (133) significantly declined from pre-diagnosis (24.7%) to during treatment (8.7%) (mean group difference, -16%; 95% CI, -12 to -20; $P &lt; 0.001$) and significantly increased from during treatment to post-treatment (25.9%) (mean group difference=17%; 95% CI, 13–22; $P &lt; 0.001$) returning to pre-diagnosis levels (mean group difference, 1%; 95% CI, -3 to 5; $P = 0.57$).</td>
</tr>
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(continued)
Meyerhardt et al. 2006 USA (105) Prospective observational (median time of follow-up 9.6 years) N = 523 females The Nurses’ Health Study cohort (134) Colorectal cancer Questionnaire - Duration of walking (with usual pace), jogging, running, bicycling, swimming laps, racket sports, other aerobic exercises, lower intensity exercise, or other vigorous activities - Pre-diagnosis PA from median 6 months before diagnosis - Post-diagnosis PA median 22 months after diagnosis = after the active treatment

More than 50% of women changed their levels of PA after diagnosis. 144 out of 523 participants increased their activity level from pre-diagnosis to post-diagnosis. 176 participants decreased their activity level, and 203 participants did not change their activity level.

Abbreviations:
CI = confidence interval, LSI of GLTEQ = Leisure Score I index of the Godin Leisure Time Exercise Questionnaire (128), (125), MET = metabolic equivalent, min = minutes, NCCCS = The North Carolina Colon Cancer Study, NC STRIDES = The North Carolina Strategies to Improve Diet, PA = physical activity, SD = standard deviation, wk = week
4.9.4 Other types of cancer

Five studies (106), (107), (108), (109), (110) examined the change in physical activity after endometrial cancer, bladder cancer, non-Hodgkin’s lymphoma, head and neck cancer, or multiple myeloma cancer (Table 12).

**Endometrial cancer**

Among endometrial cancer survivors, 29.3% met physical activity public health guidelines before diagnosis, 5.4% during treatment, and 30.6% after treatment. Based on the entire sample there were no significant declines in exercise from pre-diagnosis and after treatment. For those who received any form of adjuvant therapy, there were significant declines in exercise from pre-diagnosis to adjuvant therapy but these were recovered when more time had passed after diagnosis (106).

**Bladder cancer**

Among bladder cancer survivors, exercise levels for moderate and strenuous exercise were significantly higher at pre-diagnosis compared with 6 years after diagnosis. Results showed a significant decrease in exercise levels from pre-diagnosis to active treatment, and then a significant increase from active treatment to post-treatment, but not back to pre-diagnosis levels. In addition, 90% of the participants could be categorized into one of four groups according to their exercise across the cancer experience: maintainers (12%), temporary relapsers (4%), permanent relapsers (9%) and nonexercisers (68%) (107).

**Non-Hodgkin’s lymphoma**

Among Non-Hodgkin’s lymphoma survivors, 33.8%, 6.5% and 23.7% met public health exercise guidelines (133) during pre-diagnosis, on treatment, and off treatment time periods, respectively. All exercise behavior variables (total exercise, strenuous plus moderate, strenuous, moderate, mild exercise, and % meeting public health exercise guidelines) were significantly lower during treatment compared with pre-diagnosis, and exercise behaviour variables while off treatment were significantly higher than during treatment. However, exercise behaviour while off treatment was significantly lower than pre-diagnosis exercise behaviour (108).
**Head and neck cancer**

Before diagnosis, 34% of the head and neck cancer survivors reported some moderate or vigorous activity, and 30.5% were meeting physical activity health guidelines (≥150 min of moderate + vigorous activity and/or ≥60 min of vigorous activity per week). After diagnosis, only 5% reported some vigorous activity, 12% reported some moderate activity, and 8.5% were meeting current guidelines. All the participants who were meeting the current guidelines after diagnosis were off treatment. Overall, the mean of total weekly activity minutes decreased after diagnosis, with 44% of participants reporting less activity after diagnosis. Seven percent of the participants increased their activity from pre-diagnosis to after diagnosis, and 49% had no change in weekly activity minutes. Seventy-one percent of the participants who were meeting activity recommendations before diagnosis failed to continue at those levels after diagnosis (109).

**Multiple myeloma cancer**

Among the multiple myeloma cancer survivors, 30.0%, 6.8% and 20.4% met exercise guidelines (at least 150 min of moderate intensity or higher exercise per week) before diagnosis, during active treatment, and during off-treatment periods, respectively. Participants reported significantly lower levels of exercise (total, strenuous plus moderate, strenuous, moderate, and mild minutes, and percentage meeting national prescription guidelines) during active treatment and off-treatment periods than during the pre-diagnosis period. Moreover, exercise during active treatment was significantly lower than during off-treatment. The increase in moderate and mild intensity minutes during off-treatment was sufficient to return to pre-diagnosis levels, but strenuous plus moderate, strenuous, and total minutes of exercise remained significantly lower compared with pre-diagnosis levels (110).
Table 12 Other types of cancer and change in physical activity

<table>
<thead>
<tr>
<th>Study (authors, country, design)</th>
<th>Sample (number, gender, age)</th>
<th>Life event</th>
<th>Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courneya et al. 2005 Canada (106)</td>
<td>N = 386 women Age (mean, SD) 64.5 ± 10.6 years Mean number of months since diagnosis 52 (SD 32 months)</td>
<td>Endometrial cancer All underwent surgery, 54% received adjuvant therapy</td>
<td>Questionnaire (LSI of GLTEQ) - Exercise for three separate time periods: in the months before diagnosis, during adjuvant therapy (if applicable), and in the past month</td>
<td>29.3% of the participants met public health guidelines (CDC and ACSM (133)) before diagnosis, 5.4 % during treatment, and 30.6% after treatment. Based on the entire sample, there were no significant declines in exercise from pre-diagnosis and the past month. For those who received any form of adjuvant therapy (N = 203), there were significant declines in exercise from pre-diagnosis to adjuvant therapy but these declines were recovered during the past month.</td>
</tr>
<tr>
<td>Karvinen et al. 2007 Canada (107)</td>
<td>N = 525 74.7% male 25.3% female Age (mean, SD) 70.2 ± 11.2 years Months since diagnosis (mean, SD) 72.4 ± 42.2 months</td>
<td>Bladder cancer (surgery 97.9%, cystectomy 20.2%, immunotherapy 57.7%, CT 11.8%, RT 6.7%, any adjuvant therapy 64.8%, ostomy appliance 11.8%)</td>
<td>Questionnaire (LSI of GLTEQ) - Average frequency and duration of mild, moderate, and strenuous exercise behavior for three separate time periods: in the months before diagnosis, during adjuvant therapy (if applicable), and in the past month</td>
<td>22.3% were meeting public health exercise guidelines (133) in the past month, 16% were insufficiently active, and 61.7% were completely sedentary. Based on the entire sample, exercise levels for moderate and strenuous exercise were significantly higher pre-diagnosis (mean, 89.6 min/wk) compared with the past month (mean, 74.5 min/wk; P &lt; 0.001). For those who had received adjuvant treatment (N = 340), results showed a significant effect for time [Wilks’ Lambda = 0.86, F(2,338) = 27.96, P = 0.001]. Exercise levels dropped significantly (P &lt; 0.001) from pre-diagnosis (mean, 80.3 min/wk) to during treatment (mean, 42.2 min/wk) and then increased significantly (P &lt; 0.001) from during treatment to the past month (mean, 68.5 min/wk), but did not return to pre-diagnosis levels (P &lt; 0.001). 93% of the participants fell into four exercise patterns: maintainers (12%), temporary relapsers (4%), permanent relapsers (9%), and nonexercisers (68%).</td>
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</tbody>
</table>
### Vallance et al. 2005
**Canada** (108)

**Cross-sectional retrospective**

<table>
<thead>
<tr>
<th>N = 438</th>
<th>51.5% male</th>
<th>Age (mean, SD) 61.1 ± 13.1 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of months since diagnosis 62 months (SD 25.3 months)</td>
<td>Non-Hodgkin’s lymphoma (31.5% Ann Arbor stage IV disease 58.2% indolent forms of lymphoma) 64.6% received CT, 15.5% received both CT and RT</td>
<td>Questionnaire (LSI of GLTEQ) - PA from pre-diagnosis, on treatment and off treatment</td>
</tr>
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</table>

33.8%, 6.5% and 23.7% of participants met public health exercise guidelines (133) during pre-diagnosis, on treatment, and off treatment time periods, respectively.

Significant differences for all exercise behaviour measures (i.e. total exercise, strenuous plus moderate, strenuous, moderate, mild exercise, and % meeting public health exercise guidelines) across all three cancer-related time periods (all Ps < 0.001). All exercise behaviour variables were significantly lower during treatment compared with pre-diagnosis (all Ps < 0.001). Exercise behaviour during off treatment was significantly higher than exercise behaviour during treatment. Exercise behaviour during off treatment was significantly lower than pre-diagnosis exercise behaviour (all Ps < 0.001).

(continued)

### Rogers et al. 2006
**USA** (109)

**Cross-sectional retrospective**

<table>
<thead>
<tr>
<th>N = 59</th>
<th>83% male</th>
<th>Age (mean, SD) 58 ± 12.8 years</th>
</tr>
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<tbody>
<tr>
<td>Mean number of months since diagnosis 18.6 months (SD 50.9 months) 51% less than 6 months from diagnosis</td>
<td>Head and neck cancer (oral cavity 24% oropharynx 37% larynx 25%) (CT and/or RT 14%)</td>
<td>Questionnaire (a modified GLTEQ) - The duration and frequency of light, moderate, and vigorous activity during the past week and also during an average week over a typical month, the year before cancer diagnosis</td>
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</table>

Less than half reported some moderate or vigorous activity before diagnosis (17% and 34%, respectively). 30.5% were meeting PA health guidelines (≥150 min of moderate + vigorous activity and/or ≥60 min of vigorous activity per week) pre-diagnosis. After diagnosis, only 5% reported some vigorous activity, 12% reported some moderate activity, and 8.5% were meeting current guidelines. All five participants meeting the current recommendations at the time of the survey were off treatment. Three of the five were <6 months after diagnosis and two were >6 months after diagnosis. Overall, there was a mean decrease in total weekly activity minutes of 268.3 ± 870.2 after diagnosis, with 44% of participants reporting less activity after diagnosis. 7% increased their activity from pre-diagnosis to after diagnosis, and 49% reported no change in weekly activity minutes. 71% of the participants who were meeting activity recommendations pre-diagnosis failed to continue those post-diagnosis.
| Jones et al.  
2004  
Canada (110)  
Cross-sectional retrospective | N = 88  
58.6% male  
Age (mean, SD)  
64.4 ± 11.5 years  
Average time since diagnosis  
49.7 ± 44.0 months | Multiple myeloma cancer  
(surgery 7%  
RT 35.8%  
CT 86.5%  
avtologous stem cell transplant  
51.2%  
interferon 8.1%) | Questionnaire  
(LSI of GLTEQ)  
exercise pre-diagnosis, during active treatment, and off-treatment | 30.0%, 6.8% and 20.4% of participants met exercise guidelines (at least 150 min of moderate intensity or higher exercise per week) pre-diagnosis, during active treatment, and during off-treatment, respectively. There were significant differences across the cancer-related time periods for all exercise behaviour outcomes (total, strenuous plus moderate, strenuous, moderate, and mild minutes, and percentage meeting national prescription guidelines; P < 0.05). Exercise behaviour outcomes were significantly lower during active treatment compared with pre-diagnosis. Off-treatment total exercise, strenuous plus moderate and strenuous intensity exercise were significantly lower than pre-diagnosis (P < 0.05). Exercise during active treatment was significantly lower than during off-treatment (P < 0.05). |

Abbreviations:

ACSM = American College of Sports Medicine, CDC = Centers for Disease Control and Prevention, CT = chemotherapy, LSI of GLTEQ = Leisure Score Index of the Godin Leisure Time Exercise Questionnaire (128), (125), min = minutes, RT = radiotherapy, SD = standard deviation, wk = week
5 DISCUSSION

The aim of this systematic literature review was to examine the effects of life events on changes in physical activity by focusing on the following life event categories: transition to college/university; change in employment status; marital transitions and changes in relationships; pregnancy and the postpartum period; and cancers. Forty-eight articles met the inclusion criteria and were reviewed. Studies examining the effects of life events on physical activity are limited in number. The studies reviewed showed statistically significant changes in physical activity caused by certain life events. Transition to college or university, remarriage, mass urban disaster, and cancer diagnosis seem to decrease physical activity levels in men and women. Beginning work, changing work conditions, changing from being single to cohabiting, getting married, pregnancy and the postpartum period, and experiencing an interpersonal loss seem to decrease physical activity on women. In contrast, returning to study, divorce, and longer-term widowhood seem to increase physical activity in women. In addition, experiencing multiple life events during a certain time period seems to decrease physical activity participation in men and women. This systematic review about life change events and physical activity analyzed 39 articles which were not analyzed in the previous systematic review about life change events and participation in physical activity (32).

5.1 Multiple life events

Studies that examined the effects of multiple life events on the change in physical activity reported conflicting results. The two randomized controlled trials, (81) and (80), examined the effects of life events on participation in structured class-based or home-based exercise sessions. One longitudinal study and some cross-sectional studies have examined the effects of life events on total physical activity levels which include exercise but can also include gardening or walking to work. This may explain some of the between-study differences in the results. Two randomized controlled studies showed that life events have an effect on physical activity participation (81), (80). The most common life events reported by the participants were different in these two studies. This is believed to be due to the different age of the study samples (80). The mean age of the participants in one study (81) was 56.5 years, compared with 70.2 years in the other study (80). Different life events may have different effects on physical activity, and this may explain why the results of the two studies differ in the effects of life events on different exercise formats. Also, the longitudinal study which did not find any relationship between experiencing life events and physical activity had participants from
a different age group (27 years at baseline) (34). Those investigators also used a different questionnaire in measuring the occurrence of life events than the other two studies. Some studies (81) found no gender differences in the effects of life events on physical activity, while others (45), (80) have reported gender differences. These conflicting results might be due to between-study differences in the types of activities considered to be exercise (81). There were some differences between men and women in the life events which were reported most often. Women were more likely to report home- and family-related life events than men, and men were more likely to report work-related life events than women (81). Men and women may consider different events as being major life events and put different values on specific life events. This may explain the differences in the effects of life events between genders.

5.2 Transition to college/university

Three studies (36), (82), (75) found a decrease in physical activity after transition from high school to college or university. These results are similar to those reported in previous cross-sectional studies (46), (47). Two studies which examined transition to college or university (36), (82) collected data on vigorous physical activity only. Recall of vigorous physical activity engagement has been shown to be more accurate and reliable than recall of moderate or mild intensity activities (135), but not all types of activities are taken into account, for example walking or bicycling as commuting (82). An increase in physical activity after returning to study among young women, which was found in one study (74), may be due to better accessibility to sport and exercise facilities at college compared with at home or at work.

5.3 Change in employment status

One study found that young women who reported beginning work or changing work conditions decreased their physical activity (74), while another found that returning to work after maternity leave did not affect physical activity behavior (83). This may be due to already decreased levels of physical activity caused by the pregnancy. Two studies (115), (52) examining the change in physical activity when transitioning from working life to retirement found conflicting results. The difference between the results may be due to the use of a limited scale when measuring the number of hours spent weekly in physical activity in the study (52) which did not find an increase in sports or leisure time physical activity after retirement (136). The investigators used only three physical activity categories when
measuring sports participation, and nonsports leisure-time physical activity. These categories did not take into account smaller changes in physical activity. They also used different questionnaires for measuring physical activity for the baseline and at follow-up. Follow-up time was longer in this study (52) than in the other one (115). This suggests that increases in sports and leisure physical activity may not last for longer periods after retirement. It is not surprising that retirement was shown to lead to a decrease in work-related physical activities (52). This highlights the importance of promoting leisure time physical activity behavior in older adults to compensate for the decline in occupational physical activity after retirement. Retired people have more leisure time, and engagement in physical activities has many physiological and psychological health benefits. Participation in physical activities may also be a good way to be socially active and to prevent loneliness among older people.

5.4 Marital transitions and changes in relationships

Results from the longitudinal and the cross-sectional studies examining marital transitions or changes in relationships and physical activity show inconsistent results. Some of the differences may be explained by the different ages of the study participants. For example, getting divorced at a younger age may not affect living habits as much as getting divorced at an older age. Older women may have been taking care of the family for many years and decreased their physical activity because of that, and they may have children who are older at the time of the divorce. The other thing that may have affected the results is the use of different methods in measuring physical activity. Two studies (56), (76) used interviews, six studies (57), (74), (49), (53), (84), (39) used questionnaires, and one study (80) used participation in exercise groups and self-reported exercise logs. The questionnaires which were used differed between studies, and some studies (74), (49) used different questionnaires at baseline and at follow-up. Differences between the results of the studies examining interpersonal loss and widowhood (39), (80), (53) may be due to different follow-up times in the studies. Widowhood increased physical activity only after being widowed for one year or more in one study (39), and the time after interpersonal loss was only 6 months or less in the study (80) which, in contrast, found a decrease in physical activity. Some studies report differences in the effects of marital transitions between genders. It seems that among women, physical activity levels decrease when changing from being single to a live-in relationship, getting married or remarried, and when experiencing an interpersonal loss. Physical activity seems to increase when women get divorced or after being widowed for some time. In contrast, cross-sectional studies indicate that divorce, widowhood and remarriage decrease
physical activity levels in men. Differences between genders may be due to gender roles. The role of women in marriage is more likely to be caregiving, and this may be beneficial to their spouses’ health behavior (53). Women may be dedicating more time to household tasks and children. Married women may feel additional role demands that single woman do not experience. Some studies have shown that perceptions of role overload (a condition in which there is insufficient time in which to carry out all of the expected role functions, i.e. role of a mother, wife, occupational role) are important in determining physical activity in women (137). After a divorce or the death of a spouse, women may have more time for taking care of themselves and this may increase their physical activity. In contrast, living alone because of divorce or widowhood may lead to adverse health behaviors in men, including unhealthy eating habits, increasing alcohol consumption, and physical inactivity.

5.5 Pregnancy and the postpartum period

Consistent evidence suggests that physical activity is reduced from pre-pregnancy to during pregnancy (37). Findings from the six studies that examined the change in physical activity from pre-pregnancy to postpartum are conflicting. Two retrospective studies (85), (86) and two longitudinal studies (87), (74) found a decrease in physical activity from pre-pregnancy to postpartum, while one retrospective study (38) and one longitudinal study (88) did not. However, the longitudinal study (88) which did not find a decrease in total physical activity between pre-pregnancy and postpartum found instead a shift toward lower energy expenditure activities and a decrease in aerobic fitness and strength from pre-pregnancy to pregnancy, and then a partial rebound toward pre-pregnancy levels postpartum. The decrease in fitness and strength may indicate a decrease in higher intensity physical activity levels from pre-pregnancy to postpartum, or an overestimation in reported physical activity levels after pregnancy. Also, the weight has not usually returned to prepregnancy numbers in postpartum which may have an effect on fitness and strength. The retrospective study (38) that did not find a decrease in physical activity had participants of low socioeconomic status, whereas the participants in other studies were mostly of high socioeconomic status. This suggests that the effects of pregnancy on physical activity may differ between different socioeconomic groups. However, the recall period of physical activity levels was nearly 3 years among some participants in that study, and this may affect the accuracy of recall. In addition, this study also assessed physical activities other than leisure time physical activities, which were not assessed by all the other studies. It seems that pregnancy has a negative effect on physical activity behavior also among ethnic minorities (86), and that women who were active before
pregnancy seem to be more active also during and after pregnancy (37), (87). Having at least one other child in the home seems to decrease physical activity more than giving birth to a first child (87). Physical inactivity during pregnancy is more common among older, married, multiparous, economically disadvantaged and less educated women (37). Women should be informed about current scientific evidence on the health benefits of physical activity during and after pregnancy. This could correct any false beliefs about the adverse effects of being active during pregnancy, and increase physical activity levels among pregnant women.

5.6 Mass urban disaster or onset of a chronic medical condition

One study showed that the terrorist attacks on September 11, 2001 decreased exercise levels of New Yorkers (89). The reasons for this may include mental distress, changes in daily routines, lack of time, and other psychological, environmental and social problems caused by the attacks. One study found no significant association between the onset of a chronic medical condition and change in physical activity (93). Comparing the results of these two studies with those of other studies is not possible because of the lack of studies examining these life events.

5.7 Cancer

Six studies examining the change in physical activity since cancer diagnosis in a sample of adult mixed-cancer survivors show somewhat different results. Only two of the studies showed a statistically significant decreases in physical activity after cancer diagnosis (90), (95). Many of the studies did not analyze changes in physical activity with statistical methods. The cancer types of the participants differed between the studies, and this may influence the results because survival rates for different cancers are not the same. Patients with cancers with high survival rates (such as breast, prostate and colorectal cancers) may have different motivations for making lifestyle changes than patients with cancers with a poor prognosis (such as lung and pancreatic cancers) (92). Two studies, (40) and (95), of adolescent multi-cancer survivors (lymphoma, Hodgkin’s disease, leukemia, tumors of the central nervous system, osteosarcoma or ovarian/testicular cancer) found a decrease in physical activity from pre-diagnosis to during treatment, and only a partial rebound after treatment. It is not clear whether the decrease in physical activity from pre-diagnosis to post-treatment is caused by the effects of cancer treatment or is a result of the independent effects of adolescent maturation or other factors associated with this period of life.
Some studies examined survivors of a certain cancer type and found a decrease in physical activity levels from pre-diagnosis to post-diagnosis among breast cancer (97), (98), (99), (101), colorectal cancer (78), (103), (105), bladder cancer (107), non-Hodgkin’s lymphoma (108), head and neck cancer (109), and multiple myeloma cancer (110) survivors. Some of these studies (97), (78), (108), (110) found a decrease in physical activity levels from pre-diagnosis to during treatment, and a partial rebound during post-treatment. Two studies found a decrease from pre-diagnosis to during treatment, but a return to pre-diagnosis physical activity levels at post-treatment among colorectal cancer (104) and endometrial cancer (106) survivors. Some studies categorized four (40), (95), (107) or five (96) main exercise patterns across the cancer experience. The biggest percentage of the participants fell into the category of non-exercisers, which means that they were inactive across the whole cancer experience (pre-diagnosis, during treatment and post-treatment) (96), (107) or into the category of temporary relapsers (inactive during treatment) (40), (95). One longitudinal study (79) found an increase in non-occupational physical activity levels from pre-diagnosis to post-diagnosis among colorectal cancer survivors. However, in this study the non-cancer control group also increased their physical activity, and there were no difference in the change in physical activity between the cancer and non-cancer groups. This suggests that the increase in physical activity was not due to the cancer experience. It is not clear whether increased physical activity is related to the fact that many participants (both survivors and control group) retired after the first survey and may have had more time to be physically active or indicative of a conscious effort to increase physical activity.

One study (102) found that after breast cancer diagnosis, the usual care plus exercise group maintained or increased their physical activity less than the usual-care group. However, two demographic variables differed significantly between the exercise and usual-care groups (this was due to coincidence because participants were randomized into two groups). The usual care group had a higher mean level of education and lower mean BMI (body mass index). This may have affected the study results since both higher educational level and lower BMI are associated with increased participation in planned exercise (138). The studies show conflicting results about the effects of medical treatments on physical activity. One study (92) found that those who were receiving three or more medical treatments after cancer diagnosis were more likely to begin a new physical activity, while two studies (98), (106) report that those who received more adjuvant therapy decreased their physical activity more. Two studies found that older cancer survivors were more likely to decrease their physical activity than younger cancer survivors (93), (94).
The Leisure Score Index of the Godin Leisure Time Exercise Questionnaire (LSI of GLTEQ) was used in many studies when measuring physical activity levels across the cancer experience. The validity of the LSI of GLTEQ has been found to compare favorably with that of nine other self-reported measures of exercise based on various criteria (135). However, the reliability of measuring physical activity change in cancer survivors by relying on the memory of the participants may have been affected by the cancer symptoms or treatment. The mean time since diagnosis differed between the studies from right after the diagnosis to years after the diagnosis. Changes in physical activity may be different after more time has passed since cancer diagnosis. Cancer survivors have been shown to be receptive to the idea of making positive health behavior changes, including increasing physical activity (139), (140), (141). Cancer survivors may be a potential group for promoting a physically active lifestyle, since their motivation for health behavior changes may be heightened after the cancer experience.

5.8 Gender differences and high risk groups

Some studies indicate that some life events have different effects on physical activity between men and women (80), (82), (115). This may be due to the same reasons which affect the lower physical activity levels among women compared with men in general. Gender roles and the belief that certain types of exercise are not appropriate for women may decrease physical activity levels among women. Although these beliefs and roles are changing, being a mother who takes care of household may still affect participation in physical activities in many women. Four (82), (115), (56), (86) of the reviewed studies had a multi-ethnic sample, and two of these (82), (115) found differences between ethnic groups in physical activity changes due to life events. One study found differences in physical activity changes after a life event between people of different socioeconomic status (82). Lack of knowledge about the benefits of physical activity, lack of money and exercise facilities, and working hours/conditions may affect physical activity levels among these groups. In addition, some studies showed that people who were more physically active before maintained a higher level of physical activity even after experiencing a life event (37), (87), (102).

5.9 Limitations of the studies

Assessing physical activity was not the primary purpose of all the studies reviewed. Some studies examined the effect of a life event on health behaviors, and physical activity was assessed as one type of health behavior. Some studies had other main variables than physical activity or health behaviors. Many such studies used non-validated physical activity measures
without adequate reliability, and physical activity data were not always analyzed and reported in detail. Some studies did not analyze changes in physical activity. These studies did not usually report all the dimensions of physical activity (frequency, intensity, duration and mode) either. Also, the exact timing of the life events and behavioral changes were not known in some studies.

Most of the studies used self-reported questionnaires in measuring physical activity. Self-reported physical activity data is likely to be somewhat limited because of the recall error, perceived social desirability and other biases (142). A questionnaire is a subjective measure and participants tend to overestimate their activity levels with self-report recall measures when compared with simultaneous objective measures (143). Objective measures of physical activity include accelerometers, pedometers, GPS tracking and heart rate monitors. However, the use of objective measures is more expensive and may be impractical in studies with large sample sizes.

Studies reviewed had different study designs (30 cross-sectional studies with retrospective questionnaires, 16 prospective longitudinal studies, 2 randomized controlled trials). Thirty out of forty-eight studies used a retrospective method and relied on recall when measuring physical activity levels before the life event. In addition to possible over-reporting, recall of physical activity after a long time may be affected by memory. Another limitation is the possible cross-contamination of responses when assessing physical activity levels from before a life event and after a life event at the same time.

One study (144) found that the test-retest reliability of measuring pre-diagnosis physical activity by a telephone interview after colorectal cancer diagnosis was not particularly reliable. Categorizing participants as active, insufficiently active, or sedentary had better test-retest reliability than the continuous data. However, categorizing physical activity loses some valuable information such as detecting smaller differences in activity levels and between participants.

The participants in the studies consisted mostly of well-educated white people. In addition, 29 out of 48 studies are from the United States and 12 from Canada. The generalization of the findings to low socioeconomic status and ethnic minority populations as well as to different countries may be limited because physical activity behavior and life events may vary in different populations. Cultural and social norms and different benefits (i.e. duration of
maternal leave) may also affect physical activity change during life events in different populations.

Non-response bias may have influenced the results of some studies. In cancer studies, only the patients who survived were studied. Another important limitation of the studies is that life events tend to overlap each other: for example, marriage and pregnancy may occur at the same time. This makes measuring the effects of one specific life event difficult. It is also worth noting that although a specific life event may have an impact on physical activity, other simultaneous physical, psychological and social factors are also likely to affect an individual’s physical activity behavior.

5.10 Limitations and strengths of the review

The studies used different methods for assessing physical activity and life events, which made comparisons between studies examining the same life event difficult. Different PA questionnaires include different types of activities; for example, work-related and transportation activities were not always included. As a result, comparison of the physical activity change between different studies was not possible. Different studies collected data about physical activity before, during and after a life event at different times. For example, data on women’s physical activity behavior after pregnancy were collected at different times during the postpartum period in different studies. This makes comparisons between results difficult because physical activity behavior may change when more time has passed after pregnancy. Not all the life events which may affect physical activity were included in this review. Such life events include transition from elementary school to high school, diseases and disabilities, accidents, major changes in weight, fatherhood, moving to a new environment, change in transportation, and change in financial situation. The strength of this review is that it examined studies from a research area which is poorly reviewed. The association between life events and physical activity warrants further study.

6 CONCLUSIONS

This review suggests that major life events do affect physical activity and that different life events may have different kinds of effects on physical activity behavior. This means that people experiencing different life events could be an important target group for physical activity promotion. This aspect should be taken into account in public health work, and more
research in this area of study is needed. Future studies should also examine the specific determinants of physical inactivity during different life events.

The main conclusions are summarized below.

**General**

- Some studies indicate that the decrease in PA during life events is greater among people from ethnic minorities, people with lower socioeconomic status, and people who had lower levels of PA before the life event.
- Evidence suggests that there are differences between different age groups in the effects of life events on PA.
- Evidence suggests that there are differences between men and women in the effects of life events on PA.
- Evidence suggests that emerging adulthood is a critical time period for physical activity change, particularly for women, because of the many life events usually occurring during this time (transition to university, start of working life, cohabiting, marriage, pregnancy).
- The results highlight the importance of different life events in understanding the determinants of physical activity and in planning effective health promotion interventions to increase health-enhancing PA.

**Transition to college/university**

- Transition from high school to college or university seems to decrease PA levels.
- One study showed that returning to study (after being at home or working for a while) increased PA among young women.

**Change in employment status**

- Studies examining the effects of change in employment status on PA are limited and show conflicting results.

**Marital transitions and changes in relationships**

- Evidence on the effects of marital transitions or changes in relationships on PA is conflicting.
- Six out of nine studies reviewed showed that marital transitions or changes in relationships do affect physical activity level either by decreasing or increasing PA.
• There are differences between different age groups.

• Gender differences:
  Among women:
  - PA seems to decrease when changing from being single to a live-in relationship, getting married or remarried, and when experiencing an interpersonal loss.
  - PA seems to increase after divorce or being widowed for one year or more.
  Among men:
  - Remarriage seems to decrease PA.

*Pregnancy and the postpartum period*

• Both leisure time and work-related PA decrease from pre-pregnancy to pregnancy.
• The intensity and duration of PA decrease both during pregnancy compared with pre-pregnancy, and during the third trimester compared with the first.
• PA seems to decrease from pre-pregnancy to postpartum, but studies also show conflicting results.
• Some studies show a decrease in PA from pre-pregnancy to pregnancy, and a partial rebound postpartum.

*Mass urban disaster or onset of a chronic medical condition*

• Studies are limited.
• One study found that a mass urban disaster decreased PA levels, and another found no association between the onset of a chronic medical condition and physical activity.

*Cancer*

• Studies examining the change in PA after cancer diagnosis in a sample of mixed-cancer survivors show conflicting results.
• PA seems to decrease from pre-diagnosis to during treatment among adolescent cancer survivors, and among survivors of breast cancer, colorectal cancer, endometrial cancer, bladder cancer, non-Hodgkin’s lymphoma, head and neck cancer, and multiple myeloma cancer.
• Some studies show a partial rebound to pre-diagnosis PA levels from during treatment to post-treatment.
• Few studies show a complete return to pre-diagnosis PA levels post-treatment.
**Multiple life events**

- Cross-sectional and longitudinal studies show conflicting results.
- Two randomized controlled trials showed that experiencing multiple major life events decreases physical activity (PA) levels.
- Effects of life events on PA differ between different age groups.
- Some studies suggest gender differences.

**Recommendations**

- More opportunities should be arranged for college and university students to participate in organized exercise activities. More importantly, a broad variety of exercise activities without an emphasis on competition should be organized.
- Young women should be encouraged to be physically active regardless of the many life events which occur when entering adulthood.
- Pregnant women should be encouraged to engage in physical activities according to current recommendations for this population. Well-baby clinics in Finland are an ideal environment to encourage pregnant women to be physically active.
- Women’s beliefs about the advantages and disadvantages of exercise during pregnancy and the postpartum period should be considered when designing exercise interventions.
- Including a woman’s partner or a neighbour or a friend in exercise interventions during pregnancy and postpartum could be effective.
- Organizing a babysitter during mother’s exercise session is useful, as well as mother baby exercise, ways to exercise with a baby.
- Cancer survivors should be informed about the health benefits of PA across the cancer experience and encouraged to be physically active.
- Particular issues concerning the effects of cancer and cancer treatment should be taken into account when planning exercise programs for cancer survivors.
- PA promotion campaigns should be planned for people who are at higher risk for physical inactivity during life events: inactive people, ethnic minority groups, and people with low socioeconomic status.
- Future studies should examine the specific determinants of PA during life events (for example lack of time, lack of social support, emotions).
Future studies should assess the amount of stress caused by a specific life event.
Future studies should examine gender differences in the effects of life events on PA.
Future studies should use standardized validated methods in assessing PA.
Studies with longer follow-ups are needed to examine how long the effects of life events on PA persist.
Longitudinal studies and randomized controlled trials from different countries and cultures are needed.
References


