Predicting Factors of Physical Activity in Adolescents: A Systematic Review

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Purpose The main goal of this systematic review is to summarize and identify the current literature that addresses factors associated with adolescents' physical activity.

Methods A systematic review of the literature was undertaken using a reference period between 1998 and 2008, based primarily on the PubMed/CINAHL/PsycINFO/ProQuest databases. A total of 35 articles were considered appropriate for this review.

Results This systematic review found some evidence of associations between physical activity and the following variables: age, sex, parental education level, socioeconomic status, self-efficacy, perceived benefits, perceived barriers, perceived behavior control, parental support, parent modeling, peer support, past physical activity, depressive symptoms, smoking, alcohol consumption, and environmental determinants.

Conclusion Some variables have been studied too few times to deduce any conclusion, so more research is needed to test variables. Variables that did not have consistent results also need further testing.

Key Words adolescence, determinants, physical activity

INTRODUCTION

Regular physical activity (PA) provides adolescents with important physical, mental, and social health benefits (Department of Health, Physical Activity, Health Improvement and Prevention, 2004). In spite of these benefits, a rapid decline in PA during adolescence has been observed. According to the Third Korea National Health & Nutrition Examination Survey conducted in 2005, slightly more than half (53.4%) of the adolescents surveyed did not exercise regularly. Also, children and adolescent obesity doubled and energy intake increased by 31 kcal between 1998 and 2005 (Ministry of Health and Welfare, 2005). PA habits developed in early life may persist into adulthood. Therefore, promoting PA must start early in life. In order to plan and implement intervention to increase PA in adolescents, we need to determine the factors that play a role in affecting PA in this population. However, little is known and understood about PA in Korean adolescents, so this study used data from the English-language literature. We aimed to review the determinants and influencing factors of PA in adolescents. The research question that guided this study was: what are the determinants of physical activity in adolescents in the 5th through 12th grade?

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METHODS

Inclusion criteria
Explicit inclusion criteria were used to ensure that all relevant studies were reviewed. Studies were included if they met the following criteria: (a) subjects were in the 5th–12th grade; (b) published between 1998 and 2008; (c) measured overall PA as a dependent variable; (d) evaluated predictors, factors, and determinants of PA; (e) research reported in English.

Published and unpublished studies were included in this review. A systematic review of the literature was undertaken using a reference period between 1998 and 2008, based primarily on the PubMed/CINAHL/PsycINFO/ProQuest databases using the key words adolescent/youth/teenage, factors/determinants/predictors/correlates, and physical activity/exercise. Computerized searches were conducted on all the authors of the 222 studies that met the inclusion criteria. The titles and abstracts of the studies were screened for potential correlates of PA. After an initial review, 41 full papers were read to assess if they should be included. Six studies were excluded because PA was an independent variable. A total of 35 articles were considered appropriate for this review (Table 1).

RESULTS

Conceptual framework
The behavior of PA is the result of a complex casual web that involves several types of variables, rather than just one type. Fifteen studies used theoretical framework, including Pender’s Health Promotion Model (HPM), Self-Efficacy and Self-Schema Theory, Ecological Model, Social Ecological Model, Social-Cognitive Theory, Social-Learning Theory, Health Promotion and Trans-theoretical Model, and Theory of Planned Behavior.

Six of the studies explained adolescents’ PA using the HPM (Ammouri, Kaur, Neuberger, Gajewski, & Choi, 2007; Chang, 2004; Sherrick-Escamilla, 2007; Wu, 1999; Wu & Jwo, 2005; Wu & Pender, 2003). HPM was chosen because it integrates biological, psychological, social, and environmental aspects of human behaviors which can be used to explain the PA of youth. One study was guided by the Self-Efficacy and Self-Schema Theory, which indicates that self-efficacy has a central influence on behavior. Perceived self-efficacy is whether an individual thinks s/he can perform a specific behavior (Pis, 2006).

Humbert et al. (2006) used an Ecological Model to identify factors that influence participation in PA among youth of high and low socioeconomic status (SES). Pate et al. (2005) designed LEAP (Lifestyle Education for Activity Program) to enhance PA self-efficacy and enjoyment and teach physical behavioral skills on the basis of the Social Ecological Model.


The Health Promotion and Transtheoretical Model was used in Frenn et al.’s (2005) study. One study used the Theory of Planned Behavior to identify environmental and individual factors and their association with adolescents’ PA (De Bruijn et al., 2006). The other studies did not use any theoretical framework. A few studies examined theoretical models in the prediction of adolescents’ PA.

Methodology
Most of the studies included in this review were cross-sectional studies. Six studies were longitudinal (DiLorenzo et al., 1998; Dowda et al., 2007; Gordon-Larson, McMurray, & Popkin, 2000; Kimm et al., 2006; Ornelas, Perreira, & Ayala, 2007; Wu & Jwo, 2005). DiLorenzo et al. collected data from families (N = 111; 54 girls, 57 boys) who participated in both Phase 1 (5th and 6th grades) and Phase 2 (8th and 9th grades). Three years after Phase 1, Phase 2 was attempted. Gordon-Larson et al. investigated 20,747 eligible adolescents between April 1995 and December 1995. Ornelas et al. examined 13,246 youth in grades 7 to 12 in 1995 and then again 1 year later.
### Table 1
**Summary of Research Studies**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample</th>
<th>Measurement (PA)</th>
<th>Design</th>
<th>Theoretical framework</th>
<th>Results (associations with PA)</th>
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</thead>
</table>
| Allison et al. (2007)   | 9th–12th graders: 12,924 U.S. & 1,296 Canadians (Ontario) | 7DPAR             | Cross-sectional | No explicit theory    | - Age: inverse association (both U.S. & Canadians, M/F)  
- Decline greater among U.S. adolescents  
- Age: inverse (F)  
- Sex: M more active than F  
- Depressive symptoms: inverse (F)  
- Relationship with parents: positive (F)  
- Environmental opportunity: positive (F)  
- Norms from teachers, social support & modeling from friends: positive  
- Perceived benefits: positive  
- Perceived self-efficacy: positive  
- Perceived barriers: inverse  
- Perceived barriers identified most often were “not enough time”, “too much homework”, “too tired”  
- Past PA: positive  
- Environmental perceptions: positive |
| Ammouri et al. (2007)   | 300 adolescents; age, 10–19 years           | SAPAC            | Cross-sectional | HPM                    | - Age: inverse (F)  
- Sex: M more active than F  
- Depressive symptoms: inverse (F)  
- Relationship with parents: positive (F)  
- Environmental opportunity: positive (F) |
- Sex: M more active than F  
- Depressive symptoms: inverse (F)  
- Relationship with parents: positive (F)  
- Environmental opportunity: positive (F)  
- Norms from teachers, social support & modeling from friends: positive  
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- Perceived self-efficacy: positive  
- Perceived barriers: inverse  
- Perceived barriers identified most often were “not enough time”, “too much homework”, “too tired”  
- Past PA: positive  
- Environmental perceptions: positive |
| De Bruijn et al. (2006) | 221 (88 M, 133 F); age, 15.1 ± 1.9 years   | How many days a week are they engaged in various PA for at least 5 min at a time? | Cross-sectional | TPB                    | - Past PA: positive  
- Environmental perceptions: positive |
| DiLorenzo et al. (1998) | - Phase 1 (5th+6th grades) & Phase 2 (8th+9th grades): 111 families (57 M, 54 F)  
- Data from 111 mothers in | 3DPAR            | Longitudinal   | Social Learning Theory | <Phase 1: M/F>  
- Child’s enjoyment: positive  
<Phase 2: F>  
- Child's exercise knowledge: positive (Contd.) |
<table>
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<tr>
<th>Source</th>
<th>Sample</th>
<th>Measurement (PA)</th>
<th>Design</th>
<th>Theoretical framework</th>
<th>Results (associations with PA)</th>
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<tbody>
<tr>
<td>DiLorenzo et al.</td>
<td>both phases; data from</td>
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<td>- Mother's physical activity: positive</td>
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<td>(1998) (contd.)</td>
<td>80 fathers in Phase 2 only</td>
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<td>- Child's &amp; mother's friends modeling/support: positive</td>
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<td>&lt;Phase 2: M&gt;</td>
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<td>- Child's self-efficacy: positive</td>
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<td>- Child's exercise knowledge: positive</td>
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<td>- Parental modeling: positive</td>
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<td>- Interest in sports media: positive</td>
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<td>&lt;Longitudinal: F&gt;</td>
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<td>- Child's self-efficacy: positive</td>
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<td>- Mother's self-efficacy: positive</td>
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<td>- Enjoyment of PA: positive</td>
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<td>- Barriers: inverse</td>
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<td>&lt;Longitudinal: M&gt;</td>
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<td>- Child's exercise knowledge: positive</td>
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<td>- Perceived behavioral control: positive</td>
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<td>- Family support: positive</td>
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<td>- Self-efficacy: positive</td>
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<td></td>
<td>- Perceived barriers: lack of time, involvement in technology-related activities, influence of peers, parents &amp; teachers, concern about safety, inaccessibility of facilities &amp; cost of using them, competition, body-centered issues</td>
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<tr>
<td>Dowda et al.</td>
<td>421 girls (8th, 9th, 12th grades)</td>
<td>3DPAR</td>
<td>Longitudinal</td>
<td>Social Cognitive Theory</td>
<td>- Total support: positive (F)</td>
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<tr>
<td>(2007)</td>
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<td></td>
<td>- African-Americans recognized higher social support for PA than Hispanics</td>
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<tr>
<td>Dwyer et al.</td>
<td>73 girls; age, 15–16 years</td>
<td>Qualitative (focus group interview)</td>
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<td>- Family income: positive</td>
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<tr>
<td>Frenn et al.</td>
<td>127 African-American &amp; Hispanic 7th graders</td>
<td>CAAL</td>
<td>Descriptive cross-sectional</td>
<td>HPM/ Transtheoretical Model</td>
<td>- Total support: positive (F)</td>
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<td>(2005)</td>
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<td></td>
<td></td>
<td>- African-Americans recognized higher social support for PA than Hispanics</td>
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<tr>
<td>Gordon-Larsen et al.</td>
<td>17,766 adolescents (middle &amp; high SES), 3,933 non-Hispanic Blacks</td>
<td>7DPAR</td>
<td>Longitudinal</td>
<td>No explicit theory</td>
<td>- Family income: positive</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Method</td>
<td>Design</td>
<td>Theory</td>
<td>Factors</td>
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<td>Higgins et al. (2003)</td>
<td>5,925 M, 6,195 F; age, 12–24 years</td>
<td>Cross-sectional</td>
<td>No explicit theory</td>
<td>Participation in daily school physical education: positive, Use of a community recreation center: positive</td>
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<tr>
<td>Humbert et al. (2006)</td>
<td>Purposive sampling of 160 youths (80 M, 80 F); age, 12–18 years</td>
<td>Focus group interview</td>
<td>Ecological Model</td>
<td>Sex: M more active than F, Smoking, alcohol consumption: inverse, Social support: positive, Intrapersonal (perceived skill, competence, time) &amp; social support: positive (high- &amp; low-SES youth), Environmental factors (proximity, cost, facilities, safety): positive (low-SES youth)</td>
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<tr>
<td>Jago et al. (2007)</td>
<td>447 adolescents; age, 10–14 years</td>
<td>Self-reported PA &amp; 3 days using previously validated MTI accelerometer MVPA</td>
<td>Cross-sectional</td>
<td>No explicit theory</td>
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<tr>
<td>Kantomaa et al. (2007)</td>
<td>5,457 adolescents; age, 15–16 years (&amp; their parents)</td>
<td>How much do you participate in brisk PA (MVPA) outside school hours?</td>
<td>Cross-sectional</td>
<td>No explicit theory</td>
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<td>Kimm et al. (2006)</td>
<td>2,379 Black &amp; White girls enrolled in the NHLBI Growth &amp; Health Study since ages 9 or 10 years were surveyed for 3 consecutive years from ages 16 or 17 years</td>
<td>HAQ (MET: times per week)</td>
<td>Longitudinal</td>
<td>No explicit theory</td>
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<tr>
<td>Kristjandsottir &amp; Vilhjalmsson (2001)</td>
<td>3,270 adolescents; age, 11–16 years</td>
<td></td>
<td>Cross-national</td>
<td>No explicit theory</td>
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<tr>
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<th>Theoretical framework</th>
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</thead>
</table>
| La Torre et al. (2006)        | 1,121 M (46.5%), 1,290 F (53.5%); age, 11–17 years (median, 12 years) | Scholastic PA & extracurricular PA | Cross-sectional | No explicit theory    | - Families’ high SES: positive  
- Parents’ high educational level: positive  
- Parents’ PA: positive  
- Sex: M more active than F  
- Self-efficacy: positive  
- Friends’ & siblings’ PA: positive  
- Perceptions of athletic/physical ability, interest in organized group activities: positive  
- Use of recreation time: positive  
- Physical education class: positive  
- Commuting to school: positive  
- Perceptions of athletic/physical ability, school environment: positive  
- Friends’ & siblings’ PA: positive  
- Physical education class: positive  |
| Loucaides et al. (2007)       | 1,398 (4 urban schools) & 1,290 (4 rural schools); age, 15.6±1.3 years | Godin-Leisure Time Exercise Questionnaire | Cross-sectional | No explicit theory    | - Sex: M more active than F  
- Self-efficacy: positive  
- Friends’ & siblings’ PA: positive  
- Perceptions of athletic/physical ability, interest in organized group activities: positive  
- Use of recreation time: positive  
- Physical education class: positive  
- Commuting to school: positive  |
| Motl et al. (2007)            | 1,655 12th grade girls (39.5% African-American, 53.7% White, 3.9% other, 2.9% not reported) | 3DPAR                            | Cross-sectional | No explicit theory    | - Social support: positive  
- Self-efficacy: positive  
- Perceived neighborhood safety: none  
- Perceived equipment accessibility: positive  |
| Motl et al. (2005)            | 1,038 Black & White girls, 1-year period                              | 3DPAR                            | Longitudinal    | No explicit theory    | - Self-efficacy: none (longitudinal)  
- Perceived behavioral control: positive (longitudinal)  |
| Neumark-Sztainer et al. (2003)| 201 high school girls; age, 15.4±1.1 years                            | MVPA modified from Godin & Shephard | Cohort          | Social Cognitive Theory | - Age: inverse  
- Time constraints: inverse  
- Social support: positive  |
| Omelas et al. (2007)          | 13,246 7th–12th graders interviewed in 1995 & again 1 year later       | Weekly bouts of MVPA             | National         | No explicit theory    | - Family cohesion, parent-child communication, parental engagement: positive (both genders 1 year later)  |
### Predicting Factors of Physical Activity in Adolescents

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Sample Description</th>
<th>Study Design</th>
<th>Theory/Model</th>
<th>Key Findings</th>
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</thead>
</table>
| Pate et al. (2005)     | 2,744 girls group-randomized controlled (24 high schools; 48.7% African-American, 46.7% White) measured 8th & then 9th grade | 3DPAR Experimental cohort | Socioecological model | - Parental monitoring: none  
- Self-esteem: positive (M/F)  
- LEAP based on socioecological model drawn from social cognitive theory  
- 45% of girls in LEAP intervention schools & 36% of girls in control schools participated in vigorous PA during more 30-minute time blocks per day over a 3-day recall period |
| Petosa et al. (2005)   | 349 adolescents (183 9th graders, 166 12th graders) | PDPAR Cross-sectional | Social Cognitive Theory | - Self-regulation, self-efficacy (skill/ability), social outcome expectations, self-efficacy (barriers): positive |
| Raudsepp (2006)        | 326 Estonian urban adolescents & their parents | 7DPAR Cross-sectional | No explicit theory | - Sex: M significantly more active than F  
- Higher social class: positive  
- Fathers’ & mothers’ social support: positive |
| Robbins et al. (2003)  | 77 ethnically diverse girls; age, 11–14 years | How many days are they physically active for 60 min or more in a typical week? | No explicit theory | Top barriers: “I am self-conscious about my looks when I exercise”, “I am not motivated to be active” |
| Sherrick-Escamilla (2007) | 36 (23.8%) 10-year-olds  
57 (37.7%) 11-year-olds  
58 (38.4%) 12-year-olds | Weekly activity sum | Cross-sectional | HPM |
| Shi et al. (2006)      | 824 adolescents; age, 12–14 years | Total PA scale with active commuting to school, housework, vigorous PA | Cross-sectional | No explicit theory |

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<th>Source</th>
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<th>Measurement (PA)</th>
<th>Design</th>
<th>Theoretical framework</th>
<th>Results (associations with PA)</th>
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<tbody>
<tr>
<td>Trost et al. (2003)</td>
<td>380 7th–12th graders; age, 14.0 ± 1.6 years (&amp; their parents)</td>
<td>7DPAR</td>
<td>Cross-sectional</td>
<td>No explicit theory</td>
<td>- Parental support: positive</td>
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<td>- Parental PA: none</td>
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<tr>
<td>Vilhjalmsson &amp; Thorlindsson</td>
<td>Representative national survey of 1,131 Icelandic adolescents</td>
<td>Two items summary scale</td>
<td>Cross-national</td>
<td>No explicit theory</td>
<td>- Sex: M more active than F</td>
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<td>(1998)</td>
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<td>- Higher social class: positive</td>
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<td>- Significant others’ PA, sociability: positive</td>
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<td>- Perceived importance of sport &amp; of health improvement: positive</td>
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<td>- Satisfaction with mandatory school gym classes: positive</td>
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<td>Voorhees et al. (2005)</td>
<td>488 6th–8th graders</td>
<td>PAQ-C</td>
<td>Cross-sectional</td>
<td>No explicit theory</td>
<td>- Age: inverse</td>
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<tr>
<td>Wu (1999)</td>
<td>Convenience sample of 969 Taiwanese 8th graders</td>
<td>CAAL</td>
<td>Cross-sectional</td>
<td>HPM</td>
<td>- Self-efficacy: the most positive predictor</td>
</tr>
<tr>
<td>Wu &amp; Jwo (2005)</td>
<td>969 Taiwanese 8th graders (after 1 year, 9th graders)</td>
<td>CAAL</td>
<td>Longitudinal</td>
<td>HPM</td>
<td>- Interpersonal influences (norms, modeling, social support): positive</td>
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<tr>
<td>Wu &amp; Pender (2003)</td>
<td>832 Taiwanese adolescents; age, 12–15 years</td>
<td>CAAL</td>
<td>Cross-sectional</td>
<td>HPM</td>
<td>- Peer influence: positive</td>
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<td>- Perceived benefits: positive</td>
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<td>- Perceived barriers: inverse</td>
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</table>
|                                |                                                                        |                  |                       |                        | PA = physical activity; 7DPAR = 7-Day Physical Activity Recall; M = male; F = female; SAPAC = Self-Administered Physical Activity Checklist; HPM = Health Promotion Model; CAAL = Child/Adolescent Activity Log; TPB = Theory of Planned Behavior; 3DPAR = 3-Day Physical Activity Recall; MAQA = Modified Activity Questionnaire for Adolescents; SES = Socioeconomic status; MTI = Manufacturing Technologies Inc.; MVPA = moderate-to-vigorous PA; HAQ = Habitual Activity Questionnaire; MET = metabolic equivalent; LEAP = Lifestyle Education for Activity Program; PDPAR = Previous Day Physical Activity Recall; BMI = body mass index; PAQ-C = Physical Activity Questionnaire for Older Children.
Dowda et al. studied 421 girls (in the 8th, 9th and 12th grades) in South Carolina between 1998 and 2003.

Two studies were cross national studies (Kristjansdottir & Vilhjalmsson, 2001; Vilhjalmsson & Thorlindsson, 1998). There were two qualitative studies. One study examined perceived barriers in adolescent girls (Dwyer et al., 2006). This study showed that participants in all the focus groups perceived similar barriers though they sometimes differed in how they overcame them. The other study identified intrapersonal, social, and environmental factors that influenced participation in PA among youth living in high and low SES areas (Loucaides, Plotnikoff, & Bercovitz, 2007).

Two studies were experimental studies (Neumark-Sztainer et al., 2003; Pate et al., 2005). Pate et al. found that 45% of girls in the LEAP intervention schools and 36% of girls in the control schools participated in vigorous PA. Neumark-Sztainer et al. recruited 201 high school girls to participate in an evaluation study of a school-based obesity prevention physical education program. Three assessments (personal factors, behavioral factors, socioenvironmental factors) were performed during an 8-month period. The two strongest and most consistent factors associated with change in PA were time constraints and support for PA from peers, parents, and teachers.

**Measures**

**PA**

Each study had a different measurement for PA. Five studies used 3-Day Physical Activity Recall (3DPAR) (DiLorenzo et al., 1998; Dowda et al., 2007; Motl et al., 2005; Motl, Dishman, Saunders, Dowda, & Pate, 2007; Pate et al., 2005). Four studies used 7-Day Physical Activity Recall (7DPAR) to measure PA (Allison, Adlaf, Dwyer, Lysy, & Irving, 2007; Gordon-Larsen et al., 2000; Raudsepp, 2006; Trost et al., 2003). Randsdell et al. (2004) used the Fitnessgram Physical Activity Questionnaire, which contains three items (to report the number of days that they participated in aerobic, resistance training, and flexibility exercises in the past week). Chang (2004), Frenn et al. (2005), Wu (1999), Wu and Jwo (2005), and Wu and Pender (2003) assessed PA by self-report on the Child/Adolescent Activity Log (CAAL). The log was given to the adolescents for 5 days (Monday through Friday) a week. The coefficient for test-retest correlation was .99 (Wu). Pis (2006) measured PA with the Godin-Shephard Activity Survey. The Flesch-Kincaid reading grade level of this scale is 12. The 2-week test–retest reliability of this instrument was .84 (Godin & Shephard, 1984). Neumark-Sztainer et al. (2003) used two questions on hours of vigorous (strenuous activity during which the heart beats rapidly) and moderate (not exhausting) PA during the past week outside of physical education classes. There were seven response categories for each question, ranging from 0 to >5 hours/week. For each item, specific examples were provided (e.g. cycling fast). The questions were modified from Godin and Shephard. The range was 0.0–16.5 and test–retest reliability was .75 for vigorous PA and .74 for moderate PA.

Ammouri et al. (2007) used a modified Self-Administered Physical Activity Checklist (SAPAC). Participants self-reported each activity during a typical week. The modified SAPAC was found to have acceptable internal validity and test–retest reliability in other studies (Leupker et al., 1996). Petosa et al. (2005) used Previous Day Physical Activity Recall (PDPAR), which is a self-report instrument that segments the previous day into 30-minute time blocks. Jago, Baranowski, Baranowski, Cullen, and Thompson (2007) combined subjective and objective measures of PA. One assessed PA for 3 days using the previously validated MTI (Manufacturing Technologies Inc.) accelerometer. The other assessed self-reported PA where participants were asked if they engaged in 22 common activities at all, for less than 15 minutes, or for 15 or more minutes on the previous day. Self-reported previous-day PA was very weakly associated \( r = .103, p = .086 \) with accelerometer-determined moderate-to-vigorous PA. This result came from over-reporting of self-reported PA. Self-reported PA is subject to reporting bias and as this study has shown, PA questionnaires do not accurately quantify activity-related energy expenditure. However, self-report methods are still likely to be a principal source of...
information. Therefore, the use of combined measures may be needed to better characterize adolescents’ PA levels.

**Self-efficacy**

Wu’s (1999) measure of perceived self-efficacy in performing PA was adopted from instruments used in other studies. The instrument has 14 items and Cronbach’s α for the subscale of self-efficacy in a pilot study was .91. Chang (2004) used the *Children’s Physical Activity Self-Efficacy* scale, which consists of eight items. The Cronbach’s α of the scale was reported to range from .75 to .84 among 5th-, 6th- and 8th-grade ethnically diverse students. The validity of this scale was not reported. Pis (2006)’s self-efficacy instrument consists of seven items and the range is 0–7.

**Perceived benefits**

Chang’s (2004) and Wu’s (1999) measures of perceived benefits were adopted from instruments used in other studies. Perceived benefits were measured by a 12-item scale and the total scores for the perceived benefits scale were determined by a mean score of the 12 items. The α coefficient of Wu’s scale was .89. The validity of this scale was not determined.

**Perceived barriers**

Chang’s (2004) and Wu’s (1999) measures of perceived barriers were adopted from instruments used in other studies. Perceived barriers were measured by 14 items and the scores across all items were summed to obtain a mean score for perceived barriers. The α coefficient Wu’s scale was .83. The validity of this scale was not determined.

**Parental support**

The scale used by Trost et al. (2003) consisted of five items that assessed the weekly frequency with which parents encouraged, provided transport, or took part in PA with their child. Cronbach’s α of the scale was .78 and the 1-week test–retest reliability was $R = .81$. Ornelas et al. (2007) measured family cohesion, parental monitoring, parent-child communication, and parental engagement. The internal consistency and reliability of this scale were not identified. Dowda et al. (2007) measured parental support with five items that assessed the typical weekly frequency with which family members (adult female, adult male, other children) encouraged PA, participated in PA with the girl, provided transportation for PA, watched the girl participating in PA, or told the girl that PA was good for her. Raudsepp (2006) assessed parental support of adolescents’ PA; the two conceptually distinct factors of parental support were logistic support (three items; ranging from 3 to 12) and explicit modeling (four items; ranging from 4 to 16).

**Predicting factors**

To aid analysis across all 35 articles included in this study, the factors were categorized into five groups: (a) demographic and biologic factors; (b) psychological, cognitive, and emotional factors; (c) behavioral attributes and skills factors; (d) social and cultural factors; and (e) physical environmental factors. This categorization was used by Sallis, Prochaska, and Taylor (2000) and is based on the ecological approach to health behavior.

**Demographic and biologic factors**

Age and sex were the most consistent demographic correlates of PA behavior in adolescence. Boys were more active than girls and an inverse association between age and PA was found. SES and parents’ education level were also consistent determinants of participation in PA.

Age was inversely associated with adolescents’ PA (Ammouri et al., 2007; Kristjansdottir & Vilhjalmsson, 2001; Neumark-Sztainer et al., 2003; Voorhees et al., 2005). As adolescents became older, the level of PA decreased. One study (Shi, Lien, Kumar, & Holmboe-Ottesen, 2006) found that age was not significantly correlated with PA.

Sex was identified to be a significant predictor of participation in PA (Ammouri et al., 2007; Higgins, Gaul, Gibbons, & Van Gyn, 2003; Kristjansdottir & Vilhjalmsson, 2001; Loucaides et al., 2007; Raudsepp, 2006; Sherrick-Escamilla, 2007; Shi et al., 2006; Vilhjalmsson & Thorlindsson, 1998; Wu & Jwo, 2005). Compared with adolescent males, adolescent females were less active.
Gordon-Larsen et al. (2000) examined determinants of adolescents’ PA and inactivity patterns. Maternal education was inversely associated with a pattern of high inactivity; having a mother with a graduate or professional degree was associated with an adjusted odds ratio (aOR) of 0.61 for high inactivity. High family income was associated with increased moderate and vigorous PA and decreased inactivity.

PA and inactivity were associated with very different determinants. Although PA was most associated with environmental factors, inactivity was most associated with sociodemographic factors. Kantomaa, Tammelin, Nayha, and Taanila (2007) and La Torre et al. (2006) studied adolescents’ PA, family income and parents’ education level. High parental education level was associated with adolescents being physically active. High family income was associated with being an active sports club member in boys and girls. Adolescents’ participation in different types of PA varied according to family income. However, Raudsepp (2006) found that higher social class was related to higher level of PA participation by adolescents, but the family’s economic status was not related to the adolescents’ PA level. Thus, different PA and health promotion programs for adolescents and their parents must be developed that take into account individual, social-environmental (family-level) and physical-environmental factors.

Psychological, cognitive, and emotional factors

Sixteen studies examined variables including self-efficacy, perceived benefits, perceived barriers, depressive symptoms, exercise knowledge, enjoyment of physical activity, perceived behavior control, perceived skill, competence, PA preferences, sedentary preferences, perceptions of PA, interest in organized group activities, self-regulation, perceived importance of sport and of health improvement, and satisfaction with mandatory gym classes in school.

Various studies revealed the influence of perceived self-efficacy on PA among adolescents (Chang, 2004; DiLorenzo et al., 1998; Dowda et al., 2007; Jago et al., 2007; Loucaides et al., 2007; Motl et al., 2007; Neumark-Sztainer et al., 2003; Petosa et al., 2005; Pis, 2006; Sherrick-Escamilla, 2007; Wu, 1999; Wu & Jwo, 2005; Wu & Pender, 2003). Perceived self-efficacy was the most important predictor of PA, explaining about 19% of the variance in the PA among Taiwanese adolescents (Wu). In a comparative study of Taiwanese students and U.S. students, perceived self-efficacy directly predicted Taiwanese students’ level of PA, but indirectly predicted U.S. students’ level of PA through the mediation of perceived barriers and perceived benefits. Wu and Jwo’s prospective study found that self-efficacy was correlated with PA in boys. Self-efficacy was a predictor of PA in boys in Phase 2 (DiLorenzo et al.) and a predictor in girls longitudinally. However, Sherrick-Escamilla found that a significant relationship did not exist between perceived PA self-efficacy and total PA. Motl et al.’s (2005) study also found that self-efficacy was not longitudinally related with changes in moderate and vigorous levels of PA; they found that perceived behavior control had a longitudinal independent relationship with change in vigorous PA. Dowda et al. found that perceived behavioral control was independently associated with age-related changes in PA. Individuals who perceive more exercise benefits and fewer exercise barriers are typically more active than those who report many perceived barriers and few perceived benefits (Nahas & Goldfine, 2003).

In several studies of children and adolescents, perceived barriers were found to be a major inverse predictor of PA. Wu (1999) compared differences in perceived benefits, perceived barriers, and perceived self-efficacy between students in Taiwan and the U.S. Perceived benefits of PA were found to be a direct predictor of PA in both groups. Perceived barriers did not directly predict Taiwan students’ PA but did directly predict PA among the U.S. students. Neumark-Sztainer et al. (2003) found that time constraints were inversely associated with change in PA. Sherrick-Escamilla (2007) reported that perceived barriers to participation in PA accounted for 4.9% of the variance ($p < .01$) in self-reported total current level of PA in 10-, 11- and 12-year-old children. Chang (2004) found that among Asian-American youth, perceived barriers to PA were strongly and negatively correlated with PA. The barriers identified most often
were “not enough time”, “too much homework” and “too tired”. Robbins, Pender, and Kazanis (2003) identified the top barriers as being “I am self-conscious about my looks when I exercise” and “I am not motivated to be active”. Kimm et al. (2006) found that the most frequently cited barriers were “lack of time”, “I’m too tired”, and “they don’t interest me”.

A qualitative study was conducted by Dwyer et al. (2006) to determine adolescent girls’ perceived barriers to participation in PA. A total of 73 adolescent girls in Toronto participated in one of seven focus groups. Participants’ perceived barriers to participating in PA included: lack of time; involvement in technology-related activities; influence of peers, parents and teachers; concern about safety; inaccessibility of facilities and the cost of using them; competition; and body-centered issues. Lack of time is a major consistent barrier to adolescents participating in PA.

Several studies (Chang, 2004; Sherrick-Escamilla, 2007; Wu, 1999) found that perceived benefits were positively associated with PA. Ammouri et al. (2007) found that depressive symptoms were negatively associated with exercise participation via behavior-specific cognition/affect factors among females.

**Behavioral attributes and skill factors**
Smoking and alcohol consumption was negatively associated with PA. Past PA habits emerged as a consistent predictor of current PA. De Bruijn et al. (2006) found that past PA significantly predicted current PA. Jago et al. (2007) found that PA and sedentary preferences were strongly associated with self-reported PA but weakly associated with accelerometer PA. Higgins et al. (2003) found that adolescents who smoke and consume alcohol tend to be less physically active.

**Social and cultural factors**
Social support was a consistently important determinant, especially parental support and peer support, which were significantly and positively associated with adolescents’ PA. Social support for PA has been identified to be a key correlate of adolescents’ PA behavior (Ammouri et al., 2007; Chang, 2004; DiLorenzo et al., 1998; Dowda et al., 2007; Frenn et al., 2005; Higgins et al., 2003; Humbert et al., 2006; Motl et al., 2007; Neumark-Sztainer et al., 2003; Raudsepp, 2006; Trost et al., 2003; Voorhees et al., 2005; Wu, 1999; Wu & Jwo, 2005). Parental influence is derived from the parents’ own behaviors as role models and their advice and support. Parental support was related to child’s PA both directly and indirectly through its positive association with child self-efficacy perceptions (Trost et al.). Ammouri et al. found that a reported strong relationship with parents was associated with higher exercise participation scores in older girls. Fathers’ explicit modeling towards boys was higher compared to girls. Fathers’ and mothers’ logistic support were significantly related to adolescents’ PA. Fathers’ explicit modeling was the strongest predictor of adolescents’ PA, predicting 13.5% of the total variance (Raudsepp). Partially adjusted logit models revealed that family cohesion (odds ratio [OR], 1.09; 95% confidence interval [CI], 1.05–1.12), parent-child communication (OR, 1.13; 95% CI, 1.07–1.19) and parental engagement (OR, 1.25; 95% CI, 1.17–1.33) were all independent predictors of PA (Ornelas et al., 2007). In longitudinal analysis, Dowda et al. found that perceived family support was independently related to total metabolic equivalents (METs). Girls with higher values of perceived family support in the 8th grade had higher total MET scores in the 12th grade regardless of their values for self-efficacy or perceived behavior control. Girls who reported lower family support in the 8th grade had more rapid declines in PA, and a unit change in family support was related to approximately one third of a standard deviation change in total METs. These findings indicate that parents should encourage their children to participate in PA through a wide range of activities that include sports, recreation, transportation, work, planned exercise, and school-based physical education classes. In a cohort experimental study, Neumark-Sztainer et al. found that support for PA from parents, peers and teachers was positively associated with PA. Wu found that parental influence did not have any direct effects on PA, but peer influence had a significant direct effect on PA and also an indirect influence through perceived
self-efficacy. Friends’ PA interacted with emotional support from friends.

Physical environmental factors
Van Der Horst, Paw, Twisk, and Van Mechelen (2007) included access to facilities as the only physical environmental variable, and found that there was no significant association between access to facilities and adolescents’ PA. Unlike Van Der Horst et al.’s study, this study has been progress in the area of physical environmental factors associated with PA. Seven studies investigated the association between PA and environmental variables (De Bruijn et al., 2006; Gordon-Larsen et al., 2000; Humbert et al., 2006; Kristjansdottir & Vilhjalmsson, 2001; Loucaides et al., 2007; Motl et al., 2007; Shi et al., 2006). Perceived equipment accessibility had an indirect effect on PA through self-efficacy (Motl et al.). Humbert et al. found that low-SES youth emphasized environmental factors (proximity, cost, facilities, safety) for their participation in PA. Gordon-Larsen et al. found that participation in daily school physical education (aOR, 2.21; 95% CI, 1.82–2.68) and use of a community recreation center (aOR, 1.75; 95% CI, 1.56–1.96) were related with PA. De Bruijn et al. found that environmental perceptions were indirectly associated with PA. Loucaides et al. found that physical education classes were significantly associated with PA in rural school students. Commuting to school was associated with PA in urban school adolescents. Kristjansdottir and Vilhjalmsson reported that urban students were more physically active than rural students. On the other hand, Shi et al. found that PA was not significantly associated with where adolescents lived.

Study limitations
Most of the studies relied on self-reported data and cross-sectional study designs with descriptive statistics. To obtain more in-depth information on the predictive factors of participation in PA, more longitudinal studies are needed. Also, future research should adopt a measurement approach that uses both self-report and objective measurements to measure predictive factors and determinants of PA. A few of the studies used a theoretical framework. The use of theoretical models and constructs in PA research are important for understanding behavior change and guiding the development of effective interventions. Models can account for the possibilities of indirect and moderate effects of variables. Most of the studies did not examine the interaction effects among variables or pathways of their effects.

CONCLUSION
Overall, of the 35 studies reviewed, many variables were found to be significantly associated with PA. Most of the studies examined variables for which there is already well established evidence of a positive or negative relation with PA. The non-modifiable demographic variables were age, sex, SES, and parental educational level. Special considerations should be made for PA programs specific to these subgroups, such as inactive older adolescents, girls, and low SES adolescents. The modifiable variables identified in this review may be considered potential mediators of adolescents’ PA, so interventions should be developed to change these variables through education, family programs, or environmental and policy change. The variables whose associations with PA were inconsistent require further study. Some variables have been studied too few times to reach any conclusion, so more research is needed to test such variables.

In most of the studies, self-efficacy was a positive significant predictive factor. However, one cross-sectional study and one longitudinal study found that self-efficacy was not associated with PA. There was consistent positive association between parental support and adolescents’ PA. Parental attachment and support may have a significant beneficial impact on adolescents. Therefore, interventions such as including parents in PA programs and encouraging them to support their children’s participation in PA and to educate parents about the importance of regular PA during childhood and adolescence are needed because parents play important roles in their children’s lives.

Studies of determinants have focused largely on univariate relationships between a single determinant.
and the behavior, whereas determinants of behaviors, including PA, are likely to involve complex interrelationships among several factors. Future studies should assess not only the relationships between the potential determinants and the behavior but also the relationships among the determinants as well as a multivariate approach to build the most useful prediction models. Theory provides a structure and context for thinking logically about these determinants and their relationships. Future research will therefore need to take into account the possibilities of indirect and moderate effects of variables. Testing theoretical models requires attending to these possibilities; the results of such research will allow for better tailoring of interventions to support adolescent PA. Other possible correlates derived from theories, models, and creative thinking need to be evaluated for their ability to improve the explanation of adolescent PA.

REFERENCES


