A review of correlates of physical activity of children and adolescents

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ABSTRACT

SALLIS, J. F., J. J. PROCHASKA, and W. C. TAYLOR. A review of correlates of physical activity of children and adolescents. *Med. Sci. Sports Exerc.*, Vol. 32, No. 5, pp. 963–975, 2000. **Background:** Understanding the factors that influence physical activity can aid the design of more effective interventions. Previous reviews of correlates of youth physical activity have produced conflicting results. **Methods:** A comprehensive review of correlates of physical activity was conducted, and semiquantitative results were summarized separately for children (ages 3–12) and adolescents (ages 13–18). The 108 studies evaluated 40 variables for children and 48 variables for adolescents. **Results:** About 60% of all reported associations with physical activity were statistically significant. Variables that were consistently associated with children's physical activity were sex (male), parental overweight status, physical activity preferences, intention to be active, perceived barriers (inverse), previous physical activity, healthy diet, program/facility access, and time spent outdoors. Variables that were consistently associated with adolescents' physical activity were sex (male), ethnicity (white), age (inverse), perceived activity competence, intentions, depression (inverse), previous physical activity, community sports, sensation seeking, sedentary after school and on weekends (inverse), parent support, support from others, sibling physical activity, direct help from parents, and opportunities to exercise. **Conclusion:** These consistently related variables should be confirmed in prospective studies, and interventions to improve the modifiable variables should be developed and evaluated. **Key Words:** PSYCHOLOGY, BEHAVIOR, PUBLIC HEALTH, EPIDEMIOLOGY

Important favorable health effects of physical activity for adults are extensively documented and well accepted by health professionals (8,11,13,22). The benefits of physical activity in youth are less well documented (14). However, reviewers have identified at least modest positive effects in the population or subsamples of youth on such health outcomes as aerobic fitness, blood lipids, blood pressure, body composition, glucose metabolism, skeletal health, and psychological health (14,16).

Three groups have issued guidelines specifically for youth physical activity, and there is continuing debate over the amount and types of activity needed for health benefits. Recommendations tend to emphasize daily physical activity and encourage young people to accumulate 30 to 60 $min \cdot d^{-1}$ (3,5,16) ranging up to several hours per day (5). Because sustained moderate to vigorous physical activity has been associated with specific health benefits, this pattern of activity has also been recommended (5,16). Other recommendations have included activities to promote strength, flexibility, bone health (3), and avoidance of extended periods of inactivity (5).

Population surveys show that many young people are not meeting the guidelines. Although about 80% of adolescents are estimated to spend at least 30 $min \cdot d^{-1}$ being active, probably less than half are active at least 60 $min \cdot d^{-1}$ (12). About two-thirds of adolescent boys and one-quarter of adolescent girls report doing 20 min of sustained moderate to vigorous physical activity three times per week (12). Studies using self-report measures usually find more physical activity than those using objective measures (12). Because physical activity has important health benefits in youth and many young people are not meeting established guidelines, improving the physical activity levels of youth is an important public health challenge.

To develop effective physical activity interventions in youth, influences on, and determinants of, activity levels need to be well understood. Data from cross-sectional studies of association can help identify potential mediators of physical activity that can be targeted for change in interventions. Baranowski et al. (1) argue interventions that target strong and consistent modifiable correlates of behavior should be more effective in changing behavior. There have been several reviews of the correlates of youth physical activity (6,15,19–21,23). However, these reviews were not

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comprehensive, relied on narrative evaluations of the literature (except (21)), and restricted either the age of young people or the categories of variables included in the reviews.

The present review evaluates comprehensively the published studies of correlates of youth physical activity, includes the entire range of potential correlates, encompasses young people aged 3–18 yr, makes a semiquantitative evaluation of the results, and compares results for young people of primary school and secondary school ages. In addition to summarizing methods and results of studies, gaps in the literature are identified and directions for future research are proposed.

METHODS

Computer searches (MEDLINE and PsychInfo) and manual searches were conducted of articles in the English language literature from 1970 to 1998. Inclusion criteria were as follows: (a) subjects were in the age range of 3–18 yr, or the mean age was in this range; (b) the dependent variable was a measure of overall physical activity; and (c) variables were tested for their association with physical activity. Articles were excluded that had a primary focus on sports participation, physical activity in controlled settings, laboratory studies, case reports, expert opinion, unpublished studies, and dissertations. The studies reviewed consisted of school or community samples, used a variety of physical activity measures reflecting a range of intensities, and included both cross-sectional and prospective designs.

Detailed tables were created for coding selected study characteristics and to record results for child (3–12 yr) and adolescent (13–18 yr) studies, respectively. Some studies had multiple dependent measures or reported multiple subgroups of subjects. In these cases, the most objective or most inclusive measure of physical activity was chosen, the vigorous physical activity measure was selected (because validity was presumed to be higher than for other types of activity), or specific findings were recorded separately. A few studies reported results for both children and adolescents, so age-specific results were reported for both age groups.

In the detailed background table, the sample was described by sex, age, and ethnicity, and the design was coded as cross-sectional or prospective. The following categories were used to code quality of the physical activity measure: (a) self-report of poor or unknown reliability/validity, (b) self-report with acceptable reliability/validity, and (c) acceptable objective measure. Finally, the variables were classified as "related" or "not related" to physical activity based on statistical significance, and the direction of association for related variables was coded. The full data tables are available upon request from the authors, and all studies that met review criteria are listed in the Bibliography.

The detailed data tables were further analyzed to create tables that summarized the state of the literature for different variables. The following coding rules were used to create the summary tables.

TABLE 1. Rules for classifying variables regarding strength of evidence of association with physical activity.

% of Studies Supporting Association	Summary Code	Meaning of Code
0–33	0	No association
34–59	?	Indeterminate, inconsistent
60–100	+	Positive association
	−	Negative association

When four or more studies supported an association or no association, it was coded as 00, ++, or −−. The ?? code indicated a variable that has been frequently studied with considerable lack of consistency in the findings.

Selection and categorization of variables. Variables are not shown in the summary tables unless three or more comparisons were available. Some variables that were conceptually similar were combined if there were not enough studies to examine the variables individually. For example, a "benefits" variable was created that includes variables such as having fun and feeling healthy. For studies that examined multiple benefits, multiple associations were recorded and summarized under the general "benefits" heading. Consistent with previous reviews of the adult determinants literature, potential determinants were classified into six categories: demographic/biological; psychological/cognitive/emotional; behavioral attributes/skills; social/cultural factors; physical environment.

Coding associations with physical activity. A variety of statistical techniques were used to evaluate associations, most commonly correlations, *t*-tests, and ANOVAs. Sometimes only multivariate analyses were reported, including linear regression, logistic regression, and structural equation modeling. The column "Related to physical activity" indicates which studies reported significant associations between the variable and physical activity. Direction of association is indicated with a "+" or "−." The column "Unrelated to physical activity" indicates which studies reported nonsignificant associations between the variable and physical activity. For the most part, articles reported univariate tests assessing the significance of associations. Thus, even if multivariate tests were conducted, univariate tests were reported for consistency across studies.

Coding of analyses. Numbers in the columns refer to numbers in the Bibliography. If analyses were conducted separately for male and female subjects, "M" or "F" is indicated. If analyses were conducted for different age subgroups or different time periods (baseline, follow-up), "I" and "II" are used to indicate separate subgroup analyses. Due to the small number of studies reporting analyses specific to ethnic or socioeconomic groups, these subgroup analyses were not included in the summary tables.

Summary codes. The "Summary code" column contains a code to summarize the state of the literature for that variable. The percentages in parentheses refer to the number of associations supporting the expected association divided by the total number of associations for the variable. Based on the percent of findings supporting the association, the variable was classified as: no association, indeterminate/inconsistent, positive association, or negative association (see Table 1).

TABLE 2. Child and adolescent studies categorized by sample size and quality of physical activity assessment.

	Child Studies (Biblio. No.)	Adolescent Studies (Biblio. No.)
Total sample size (*N*)		
<100	9, 22, 23, 24, 32, 34, 43, 45, 48, 49, 55, 58, 68, 84, 98, 100, 104	4, 11, 20, 53
100–199	10, 15, 17, 19, 30, 31, 38, 52, 62, 83, 96, 105	12, 19, 26, 28, 42, 65, 66, 67, 97, 103
200–299	37, 54, 64, 76, 78, 81, 87, 89	7, 8, 20, 20, 25, 57, 92, 93, 102
300–399	21, 59, 70, 82, 101	13, 39
400–499	47, 85, 91	
500–999	46, 63, 73, 78, 80, 90, 95	6, 14, 16, 33, 35, 36, 40, 41, 72, 74, 77, 96, 107
1000–2999	60, 86, 94	2, 3, 14, 27, 44, 50, 51, 75, 79, 99, 108
3000–4999		1, 5, 61, 69, 106
5000+		56, 71, 88
Physical activity measure		
Self-report of poor or unknown reliability/validity	17, 21, 43, 46, 73, 76, 86, 87, 90, 91, 94, 95, 96, 98	1, 2, 4, 5, 6, 12, 13, 16, 18, 25, 27, 28, 33, 35, 36, 39, 44, 50, 51, 53, 56, 57, 61, 65, 66, 67, 69, 71, 74, 75, 79, 88, 92, 93, 96, 97, 99, 106
Self-report with acceptable reliability/validity	15, 19, 24, 37, 38, 60, 63, 70, 78, 78, 80, 83, 89, 101, 105	3, 14, 19, 20, 20, 20, 26, 40, 41, 42, 72, 77, 102, 103, 107, 108
Acceptable objective measure	9, 10, 22, 23, 30, 31, 32, 34, 45, 47, 48, 49, 52, 54, 55, 58, 59, 62, 64, 68, 81, 82, 84, 85, 100, 104	7, 8, 11
Prospective design	15, 17, 30, 38, 43, 58, 64, 68, 78, 80, 85, 87, 94	4, 13, 20, 26, 36, 74, 77

Tallies were also calculated to summarize characteristics of the youth physical activity determinants literature, including: mean sample size, number of studies reporting sex-specific results, number of cross-sectional versus prospective designs, and quality of physical activity measures.

RESULTS

Correlates of children's physical activity. From 102 published papers, 54 studies of children were reviewed. The child papers were published between 1976 and 1999, with 76% of the studies published in the 1990s. Sample sizes ranged from 20 to 1681, with a mean of 321 (SD = 367). A cross-sectional design was used by 76%. Between one and 31 variables were tested in each study, with a mean of 5.9 (SD = 6.1) variables. About 60% of reported associations were statistically significant. Results were reported for combined genders by 65%, separately by gender for 28%, and for female subjects only by 7%. Thirty percent of studies had subjects from one race, and 26% did not report the race or ethnicity of the subject sample. Only one study reported racial/ethnic differences in associations (18). Over 80% of the studies were conducted in the United States. Concerning the quality of the physical activity measure, 24% were unvalidated self-reports, 28% were empirically supported self-reports, and 48% were objective measures. Table 2 presents the studies reviewed categorized by sample size and quality of physical activity assessment. Studies with prospective designs are also identified; remaining studies are cross-sectional.

Table 3 summarizes associations between potential correlates and physical activity that were examined in at least three studies of children aged 4–12 yr. The review identified 11 demographic and biological variables, and seven were studied three or more times. The most often studied variable in the table was sex, and in 81% of comparisons, boys were more active than girls. Body weight/adiposity and age were frequently studied, but findings of negative associations with physical activity were inconsistent for both variables. Age was inconsistently related to physical activity within this narrow age range. Indicators of socioeconomic status were not related to children's physical activity. Most studies found ethnic minority children were as active as non-Hispanic whites. Surprisingly, overweight parents tended to have more active children.

Fifteen psychological variables were reported, with 12 appearing in three or more studies. The most consistent negative correlate was perceived barriers. Intention to be physically active and preference for physical activity had consistent positive associations. Several frequently studied variables had no association: body image, self-esteem, perceived benefits, attitudes toward sweating, and after school activity. Self-efficacy, perceived competence, and attitudes had indeterminate relations with children's physical activity.

Eighteen behavioral variables were studied, and six of them appeared three times or more. Time in sedentary pursuits, such as television viewing, was the most frequently studied behavior, and its relation to physical activity was indeterminate. Only healthy diet and previous physical activity had consistent positive associations with physical activity. Smoking, alcohol use, and calorie intake were unrelated to children's physical activity.

Twenty-one social variables, mainly related to parent influences, were studied, with nine appearing three or more times. Parental physical activity was the most frequently studied variable in this category, and 38% of 29 studies showed a positive association with children's physical activity, resulting in an indeterminate summary code. Parent participation in child physical activity was also indeterminate. All of the other social variables were classified as no association.

Eleven physical environment variables were studied, with six reported at least three times. Access to facilities and programs and time spent outdoors were positively and consistently related to children's physical activity. Season and milieu (rural/urban) were classified as indeterminate. Rated

TABLE 3. Summary of studies of determinants of physical activity in children: based on studies including children aged 4–12.

Determinant Variable	Related to Physical Activity		Unrelated to Physical Activity	Summary Code	
	Biblio. No.	Assoc. (−/+)	(Biblio. No.)	Assoc.	% Studies
Demographic and biological factors					
Age	9, 17, 43(F), 48(M, F), 64, 80, 90(M, F)	−	10, 19(F), 37, 43(M), 49, 63	??	9/19
	19(M), 46, 70, 85	+			47%
Ethnicity (EuroAm)	59, 81(M, F), 82	+	10, 37, 68, 70, 80(I-M, F)	??	4/11
	63	−			36%
Sex (Male)	9, 10, 15(II), 30, 37, 38, 43, 46, 47, 49, 52, 55, 59, 63, 70, 73, 80(I, II), 82, 85, 86, 87, 90, 91, 101	+	15(I), 19, 31, 48, 54, 68	++	25/31 81%
Socioeconomic status	32, 46(M, F), 47(M)	+	17, 47(F), 80(I-M, F), 81(M), 82, 90	00	4/13
	52, 81(F)	−			31%
Single parent status	81(M)	+	81(F)	0	1/4
			80(I-M, F)		25%
Body mass index	21, 22, 23, 47(M), 47(M), 48(M, F), 55, 81(M), 86(M, F), 95(M), 95(M), 105, 105, 105	−	46(M, F), 47(F), 47(F), 58, 82, 83, 85, 91, 95(F), 95(F), 100, 101	??	16/31 52%
	54, 81(F)	+			
Parent overweight/obesity	45, 54, 83 (dad)	+	31, 83(mom)	+	3/5 60%
Psychological, cognitive, and emotional factors					
Self-esteem		+	17, 37, 80(I-M, F), 80(II-M, F)	00	0/6 0%
Perceived competence (physical, sports)	24, 32, 80(II-M, F)	+	37, 80(I-M, F)	??	4/7 57%
Self-efficacy	15(I), 70, 70, 101	+	15(II), 37, 70, 89(M, F)	??	4/9 44%
Body image			80(I-M, F), 80(II-M, F)	00	0/4 0%
Attitudes, outcome expectation	15(I, II), 24, 38, 70, 80(I-M), 89(M, F)	+	70, 80(I-F), 80(II-M, F), 96(I), 98	??	8/14 57%
Sweat attitudes			80(I-M, F), 80(II-M, F)	00	0/4 0%
After school activity attitudes			80(I-M, F), 80(II-M, F)	00	0/4 0%
Dislikes PE	96(I)	−	80(I-M, F), 80(II-M, F)	00	1/5 20%
PA intention	80(I-M), 80(II-F), 98	+	80(II-M), 80(I-F)	+	3/5 60%
PA preference	17, 80(I-M), 80(II-F)	+	80(I-F), 80(II-M)	+	3/5 60%
Perceived benefits	37	+	17, 17, 17, 17, 17, 98	00	1/7 14%
General barriers	37, 89(M, F)	−		−	3/3 100%
Behavioral attributes and skills					
Cigarette use	21	+	76, 96(I)	0	1/3 33%
Alcohol use			21, 76, 96(I)	0	0/3 0%
Healthy Diet	21, 96(I), 96(I)	+		+	3/3 100%
Caloric intake	104	−	46, 85	0	1/3 33%
Previous PA	38, 68, 94(M, F), 98	+	37	++	5/6 83%
Sedentary time (TV, video games)	10, 30, 70, 78(I-F), 80(I-M), 101	−	37, 46, 78(II-F), 80(I-F), 80(II-M), 82, 89(M, F)	??	6/15 40%
	80(II-F)	+			
Social and cultural factors					
Parent PA	17, 32, 34, 47(M), 62(M, F), 62(M, F), 73, 83, 84	+	34, 37, 47(F), 57(M, F), 70, 70, 80(I-M, F), 80(II-M, F), 81(M, F),	??	11/29
	89(F)	−	82, 89(M, F), 89(M)38%		
Parent PA participation with youth	47(F), 80(I-M, F), 80(II-M), 89(M)	+	47(M), 80(II-F), 81(M, F), 89(F)	??	5/10 50%
Parent benefits of PA			57, 89(M, F)	0	0/3 0%
Parent barriers to PA			57, 89(M, F)	0	0/3 0%
Parental encouragement, persuasion	17, 55, 58, 80(II-M)	+	47(M, F), 54, 80(I-M, F), 80(II-F), 81(M, F), 98	00	4/13 31%
Parent transports child	80(II-M), 81(M)	+	47(M, F), 80(II-F), 80(I-M, F), 82(F)	00	2/8 25%

TABLE 3. Continued.

Determinant Variable	Related to Physical Activity		Unrelated to Physical Activity (Biblio. No.)	Summary Code	
	Biblio. No.	Assoc. (−/+)		Assoc.	% Studies
Parent pays PA fees	80(II-M)	+	80(I-M, F), 80(II-F)	0	1/4 25%
Subjective norms	70	+	37, 98	0	1/3 33%
Peer influence	89(M)	+	70, 89(F)	0	1/3 33%
Physical environment factors					
Access to facilities/programs	37, 82, 89(F)	+	89 (M)	+	3/4 75%
Parent provides transportation to PA	81(M)	+	47(M, F), 81(F)	0	1/4 25%
Season (Summer/Spring)	38, 73	+	90	?	2/4 50%
	10	−			
Milieu (rural)	46(M), 87	−	46(F), 90	?	2/4 50%
Neighborhood safety			80(I-M, F), 80(II-M, F)	00	0/4 0%
Time outdoors	10, 54, 82	+		+	3/3 100%

Ref. No., reference number; Assoc., association; −, negative, +, positive; 0, no relation; ?, indeterminate; EuroAm, European American; PA, physical activity; PE, physical education; M, male; F, female; I, sample 1; II, sample 2.

neighborhood safety and parents providing transportation to a physical activity place were unrelated to activity level.

Correlates of adolescents' physical activity. A total of 54 studies of potential correlates of physical activity among adolescents aged 13–18 yr were reviewed. These studies were published between 1970 and 1998, with 76% of studies published in the 1990s. Sample sizes ranged from 51 to 7302, with a mean of 1286 (SD = 1645). Eighty-three percent of studies used a cross-sectional design. Studies evaluated a range of 1 to 28 variables, with a mean of 7.4 (SD = 6.1) variables. Sixty-two percent of variables had statistically significant associations. Results were reported for combined genders by 52% of studies, 43% of studies reported associations separately by sex, and 6% had female-only samples. Of the adolescent studies, 57% had samples of one race only, 9% did not report race or ethnicity, and 7% reported associations separately by race or ethnic group. Sixty-eight percent of studies were conducted in the United States. In the classification of physical activity measures, 69% were unvalidated self-reports, 28% were empirically supported self-reports, and 4% were objective measures. Table 2 presents the studies reviewed categorized by sample size and quality of physical activity assessment. Studies with prospective designs are also identified; remaining studies are cross-sectional.

Table 4 summarizes associations between potential correlates and physical activity that were examined in at least three studies of adolescents aged 13–18 yr. The review identified nine demographic and biological variables, and five were studied three or more times. The most consistently supported finding in this group was that boys were more active than girls, and 27 of 28 comparisons supported this conclusion. A negative association between age and physical activity was found in 70% of the 27 comparisons. Ethnicity was consistently related, with non-Hispanic whites being more active than other ethnic groups. Findings regarding adolescent body weight and adiposity were indeterminate, and socioeconomic status was unrelated to youth physical activity.

Thirty-five psychological variables were reported, after combining similar constructs, with 17 appearing three or more times. Several types of perceived benefits were grouped together, and of these 29 comparisons, only 38% were significant and positive, making this association indeterminate. Barriers was the next most commonly studied category of variables. Of the 15 comparisons, 33% were significant, so barriers was classified as unrelated. Self-efficacy was categorized as indeterminate, as were body image, attitudes, knowledge, and enjoyment of physical education. Variables found to have no association were talks loudly, external locus of control, self-esteem, self-motivation, enjoys exercise, and perceived stress. Of the 17 psychological variables, the only ones with consistent and positive associations with physical activity were achievement orientation, perceived competence, and intention to be active. Depression was the only psychological variable negatively correlated with adolescent physical activity.

Of the 30 behavioral variables, 13 were reported three or more times. The only consistently positive associations were found for sensation seeking, previous physical activity, and participation in community sports. Among the frequently studied variables, cigarette smoking was indeterminate, alcohol use was unrelated, healthy diet was unrelated, and sedentary time was unrelated. In contrast, sedentary behavior after school and on weekends was consistently and inversely related to adolescent physical activity.

Twenty-three social variables were assessed, with 10 reported three or more times. Parent physical activity levels were reported most frequently, with 27 comparisons, but results showed no association. However, measures of parental support, direct help from parents, and support from "significant others" were consistently related to adolescent

TABLE 4. Summary of studies of determinants of physical activity in adolescents: based on studies including adolescents aged 13–18.

Determinant Variable	Related to Physical Activity: Biblio. No.	Related to Physical Activity: Assoc. (−/+)	Unrelated to Physical Activity (Biblio. No.)	Summary Code: Assoc.	Summary Code: Studies (*M*)
Demographic and biological factors					
Age	3(F), 4(M, F), 5(F), 8(F), 14, 16, 19(M, F), 20(III), 36(M, F), 56, 69, 96, 103(M), 107(F), 108(M, F)	−	3(M), 8(M), 18, 41, 97, 103(F)	−−	19/27 70%
	5(M), 42	+			
Ethnicity (EuroAm)	3(M, F), 5(M, F), 14, 44, 56, 69, 102(F), 107(F)	+	97, 102(M), 108(M, F)	++	10/14 77%
Sex (Male)	3, 4, 5, 6, 7, 18, 19, 20(I, II, III), 33, 36, 40, 41, 42, 44, 50, 56, 69, 72, 74, 75, 88, 97, 102, 106, 108	+	103	++	27/28 96%
Body mass index/skinfolds	74(M, F), 75(M), 75(M, F), 107(F)	−	5(M, F), 5(F), 7, 14, 74(M, F), 75(F), 77(I-M, F), 77(II-M, F), 108(M)	00	6/21 29%
	5(M), 108(F)	+			
Socioeconomic status	44, 56, 56	+	3(M, F), 14, 36(F), 97	00	3/9 33%
	36(M)	−			
Psychological, cognitive, and emotional factors					
Achievement orientation	27, 27, 69, 96(II, III)	+	96(I)	++	5/6 83%
Talks loudly	96(III)	+	96(I, II)	0	1/3 33%
External locus of control	35	−	35, 93(M)	00	1/4 25%
	93(F)	+			
Self-esteem	33, 65(III)	+	11(M, F), 16, 28(M), 65(II)	00	2/9 22%
	28(F), 65(I)	−			
Perceived physical appearance/body image	28(F), 108(M, F)	+	11(M, F), 28(M), 69	??	3/7 43%
Self-efficacy	77(I-M, F), 77(II-M, F), 102(M), 108(M, F)	+	14, 26(M, F), 102(F), 102(M, F)	??	7/13 53%
Attitudes, outcome expectation	14, 16, 102(M)	+	65(I, II, III), 102(F)	??	3/7 43%
Perceived competence	11(M), 33	+	11(F)	+	2/3 66%
Intention	35, 41, 77(I-M, F), 77(II-M, F)	+	12, 14	++	6/8 75%
Self-motivation	93(F)	+	28(M, F)	0	1/3 33%
Likes PE	96(III), 102(F), 108(M, F)	+	16, 33, 96(I, II), 102(M)	??	4/9 44%
Benefits of PA	33, 39(M, F), 39(M, F), 39(M, F), 39(F), 93(F), 97, 108(F)	+	14, 39(M), 39(M, F), 39(M, F), 39(M, F), 39(M, F), 39(M, F), 67, 93(F), 93(F), 93(M), 93(F), 108(M)	??	11/29 38%
Enjoy exercise			14, 26(M, F), 39(M, F)	00	0/5 0%
Stress	66	−	13, 13, 77(II-M, F), 77(I-M, F)	00	1/7 14%
Depression	13, 57, 66	−	35	−	3/4 75%
General barriers	39(F), 92, 93(M), 102(M, F)	−	14, 13, 39(M), 67, 92, 92, 92, 92, 108(M, F)	00	5/15 33%
Knowledge of exercise/ health	12, 26(M, F), 44	+	14, 33, 67	??	4/7 57%
Behavioral attributes and skills					
Sensation seeking	2, 79, 97	+		+	3/3 100%
Fighting			69, 96(I, II, III)	00	0/4 0%
Cigarette use	2, 69, 74(M, F), 79, 99	−	14, 39(M, F), 96(I, II, III), 106(F), 108(M, F)	??	6/15 40%
Chewing tobacco	96(II)	+	96(I, III)	0	1/3 33%
Alcohol use	69(F), 79	+	2, 39(M, F), 69(M), 92, 96(I, II, III), 108(M, F)	00	2/13 15%
	99	−			
Healthy diet	2, 74(M), 79, 96(I)	+	2, 74(M, F), 74(M), 96(I, II, III), 96(II, III), 96(I, II, III)	00	4/16 25%
Meal regularity	96(I, II)	−	2, 96(III)	?	2/4 50%
Previous PA	26(M), 41, 50(M, F), 74, 77(I-M, F), 77(II-M, F), 103(M, F)	+	26(F)	++	11/12 92%
Community sports	14, 33, 96(I, II, III), 102(M, F)	+		++	7/7 100%
On school sports teams	69	+	102(M, F)	0	1/3 33%
Sedentary time (TV, video games)	5(M), 14, 26(M(dad report))	−	5(F), 26(M(mom)report)), 26(F(mom report)), 26(F(dad report)), 102(M, F), 107(F), 108(M, F)	00	3/12 25%
Sedentary after school	96(I, II, III)	−		−	3/3 100%
Sedentary on weekend	96(I, II, III)	−		−	3/3 100%
Social and cultural factors					
Parent activity/modeling	1(F), 41, 41, 42, 44, 71, 71, 71, 72	+	1(M, F), 1(M), 12, 14, 26(M, F), 26(M, F), 26(M, F), 42, 102(M, F), 102(M, F), 108(M, F)	00	9/27 33%
Sibling PA	1(M, F), 71, 72	+		++	4/4 100%
Peer modeling			14, 102(M, F), 108(M, F)	00	0/5 0%
Direct parental help in PA	6(M, F), 108(F)	+	108(M)	+	3/4 75%
Parents support	16, 72	+	53	+	2/3 67%
Teacher support or modeling			12, 39(M, F), 40, 108(M, F)	00	0/6 0%

TABLE 4. Continued

Determinant Variable	Related to Physical Activity: Biblio. No.	Related to Physical Activity: Assoc. (−/+)	Unrelated to Physical Activity (Biblio. No.)	Summary Code: Assoc.	Summary Code: Studies (*N*)
Support from significant others	6(M, F), 12, 16	+		++	4/4 100%
Support from peers	39(F), 108(M)	+	14, 39(M), 108(F)	?	2/5 40%
Coach support/modeling	39(M), 108(F)	+	39(F), 108(M), 108(M, F)	00	2/6 33%
Subjective norms/Social influence	41, 77(I-M, F), 77(II-M, F), 102(M)	+	14, 67, 102(F), 108(M, F)	??	6/11 55%
Physical environment factors					
Equipment/supplies available	16	+	26(M, F), 92, 102(M, F), 108(M, F)	00	1/8 13%
Opportunities to exercise	39(M, F)	+	14	+	2/3 66%
Sports media influence	26(M)	+	14, 26(F)	0	1/3 33%

Ref. No., reference number; Assoc., association; −, negative, +, positive; 0, no relation; ?, indeterminate; EuroAm, European American; PA, physical activity; PE, physical education; M, male; F, female; I, sample 1; II, sample 2; III, sample 3.

physical activity. Sibling physical activity was consistently related. Peer modeling of physical activity was unrelated, and perceived support from peers was indeterminate. Subjective norms, or perceived attitudes of significant others, were often studied, but this variable was classified as indeterminate. There was no association with teacher or coach support or modeling.

Seven variables in the physical environment category were reported, and three had three or more comparisons. Opportunities to exercise had consistently positive associations. Other variables were unrelated to adolescent physical activity.

Comparison of children's and adolescents' findings. Table 5 summarizes the number of variables studied for each category and lists the variables with the strongest evidence of association with children's and adolescents' physical activity. There was very little overlap in consistently correlated variables for both age groups. The only variables listed for both were sex (male), intention to be active, and previous physical activity. In the physical environment category, the variables of access to programs/facilities for children and opportunities to exercise for adolescents appeared to be similar. Table 2 shows that methodology differed across studies of children and adolescents. Studies of adolescents had larger sample sizes ($F(1,107) = 18.19$, $P < 0.001$) and were more likely to use self-report physical activity measures ($\chi^2 = 32.1$, $P < 0.001$). By contrast, almost half of the studies of children used objective physical activity measures.

Additional analyses were conducted to examine relations between methodological variables and proportion of significant associations in studies. The correlation between significant associations and sample size was not significant for children ($r = -0.06$), but it was significant for adolescent studies ($r = 0.29$, $P < 0.05$). Quality of physical activity measure was not related to proportion of significant associations for either the child or adolescent studies. Of 40 variables studied with children, 23% were classified as "consistently related," which was not significantly different from the 35% "consistently related" variables out of 48 studied in adolescents.

DISCUSSION

Identifying correlates of youth physical activity is considered to be of public health significance (22), because such information could inform efforts that seek to increase the proportion of young people who meet health-related physical activity guidelines (17). Past narrative reviews have been selective and have come to discrepant conclusions (19,22). The most recent review that dealt with both children and adolescents was the 1996 Surgeon General's Report on physical activity (22), and the conclusions are somewhat different from those drawn from the present semiquantitative review.

In the 1996 review the most consistent modifiable correlates, as opposed to demographic factors, were identified as self-efficacy, physical or sports competence, perceived benefits, perceived barriers, intention, enjoyment, physical education attitudes, parental encouragement, direct help from parents, peer and sibling support, access to play spaces and equipment, and time spent outdoors. Multiple studies were cited in support of each variable, and inconsistent associations between parent and child physical activity were also noted (22). Of the 12 variables identified in the Surgeon General's Report, nine were confirmed as consistently associated with physical activity of children or adolescents in the present review: perceived physical competence, intention, barriers, parent support, direct help from parents, support from significant others, program/facility access, opportunities to be active, and time outdoors.

As in previous reviews, significant variables were found in all categories of correlates (19), supporting an interpretation that youth physical activity is a complex behavior determined by many factors. This result also supports ecological models of behavior that posit behavioral influences from personal (biological, psychological, behavioral), social, and physical environmental factors (17). The implication is that interventions must target changes in variables from all categories to achieve substantial behavior change (1). However, it was surprising that social correlates of children's physical activity was the only instance of a category with no consistent correlates. Previous reviews have concluded that social, especially parental, influences on

TABLE 5. Comparison of variables consistently associated with child and adolescent physical activity.

Category of Variable	Child Results	Adolescent Results
Demographic, biological		
No. of variables ≥ 3 comparisons	7	5
Variables consistently related to PA	Sex (male) ++ Parent overweight +	Sex (male) ++ Ethnicity (white) ++ Age −−
Psychological, cognitive, emotional		
No. of variables ≥ 3 comparisons	12	17
Variables consistently related to PA	PA preference + Intention + Barriers −	Achievement orient. ++ Intention ++ Perceived physical competence + Depression −
Behavioral attributes and skills		
No. of variables ≥ 3 comparisons	6	13
Variables consistently related to PA	Previous PA + Healthy diet +	Previous PA ++ Community sports ++ Sensation seeking + Sedentary after school − Sedentary on weekends −
Social and cultural		
No. of variables ≥ 3 comparisons	9	10
Variables consistently related to PA	None	Parent support ++ Support from significant others ++ Sibling PA ++ Direct help from parents +
Physical environment		
No. of variables ≥ 3 comparisons	6	3
Variables consistently related to PA	Program/facility access + Time outdoors +	Opportunities to exercise +

PA, physical activity; +, ++, positive association; −, −−, negative association.

children's activity are strong (19–21), but this more comprehensive review demonstrated a lack of consistency for associations with social variables.

One of the most notable results may be the lack of consistency across studies. Only about one-quarter to one-third of variables examined more than three times met the current definition of consistently related to child or adolescent physical activity. Very few of these variables were significant in all comparisons. Between 40 and 50% of variables were found to have no association, although studies were rarely unanimous in reporting null findings. It may be premature to dismiss all the variables in the no association group, because methodological problems may be affecting the results. About 20–28% of variables were placed in the indeterminate category. It is particularly difficult to draw conclusions about these variables, because approximately half the studies found an association and half did not. The lack of consistency in findings could be due to differences in measurement or sample. There may be confounding or moderating variables that need to be accounted for in analyses.

It is useful to consider some of the possible explanations for the substantial inconsistencies. A possible explanation is measurement error. It is challenging to measure physical activity in young people, and all available measures have substantial error and known limitations (10). Fewer significant associations would be expected in studies that relied on unvalidated self-report measures. However, no association was found between the quality of the physical activity measure and the proportion of significant associations in the studies of either children or adolescents.

Sample size has a direct bearing on likelihood of declaring a statistically significant result. The expected moderate correlation between sample size and proportion of significant associations was documented in the adolescent studies, but sample size did not appear to impact results of the child studies.

Another reason for the inconsistent findings may be sample characteristics. Two studies could use the same measures and protocols on samples of the same size, but if one sample is from a high-income population and the other sample is low-income, then different findings could be obtained. The effect of sample characteristics on correlates of youth physical activity is an important question, but it has not been explored systematically. It would be valuable for studies to report on subgroups within the same study that differ on ethnicity, socioeconomic status, and environmental characteristics (e.g., urban vs rural). There may be different correlates of physical activity for boys and girls. Although sex-specific analyses are sometimes reported, there are too few studies using the same variables to permit sex comparisons in the present review.

Different analysis strategies can also affect results. Most studies reported bivariate associations using correlations, *t*-tests, or ANOVAs. Thus, bivariate results were used when available to construct the summary tables. Some studies used multivariate techniques such as linear regression, logistic regression, or LISREL. A typical finding is that fewer variables are significant in multivariate analyses than in bivariate analyses, so there is a bias toward null findings from studies that reported only multivariate results.

Measurement error, variation in sample size, differences in sample characteristics, and different analysis strategies all increase the likelihood of inconsistent findings across studies. Thus, the variables whose associations with physical activity were supported by multiple studies should be inter-

preted carefully. The most frequent and most consistent finding was that boys are more active than girls. This result supports data from population studies (12,22) and implies that special efforts are needed to increase physical activity in girls. For adolescents only, non-Hispanic whites were more active than other ethnic groups, and this has also been found in epidemiologic studies (22). There is continuing debate over the extent to which ethnic differences in health outcomes and health behaviors are due to the confounding effect of socioeconomic status. In this review, socioeconomic indicators were not related to physical activity, but this complex variable was not included in many studies. Age was expected to be a strong correlate of physical activity (22), but this was only found for adolescents. The lack of consistent findings in children may be due to the tendency for the children's studies to include a narrower age range in the sample, which would suppress any association.

Present findings confirm the complex and inconsistent relation between physical activity and body weight-related variables in young people (2). There were a total of 55 comparisons for this variable, and results were indeterminate for children and adolescents.

Relatively few psychological variables were assessed with children, likely due to their limited cognitive abilities to self-report these variables. Four of 17 psychological variables were consistently supported for adolescents. The positive association with achievement orientation, primarily related to academics, is interesting and may reassure educators that being physically active does not reduce adolescents' interest in academics. Lack of consistency for knowledge is consistent with findings that knowledge of physical activity or health is rarely related to physical activity in adults (17). The consistent results regarding intention to be active are also similar to findings for adults (17).

Previous physical activity is one of the few variables consistently related to physical activity in both age groups. This is indirect evidence of tracking of activity levels over time, supporting prospective studies that show moderate levels of tracking over periods of several years (9). Community sports participation was related to adolescent physical activity, whereas participation in school sports was not. This supports recommendations from the Centers for Disease Control and Prevention (4) to increase the number of community activity programs and encourage more young people to participate. Although time spent watching television is generally unrelated to activity levels, use of afterschool and weekend time for sedentary pursuits was a consistent correlate for adolescents. This identifies sedentary behaviors as competitors for adolescents' time during these critical periods and may help explain why interventions to decrease sedentary time result in increased activity (7).

The strong relation of social support from parents and others with adolescent physical activity was expected and suggests that parents still play important roles in their teenagers' lives. Thus, parents can be encouraged to support their teens' physical activity verbally and with direct assistance such as paying fees. Parental physical activity was the most frequently studied social variable, but it was unrelated or indeterminate for both age groups. There may be some situations in which parent modeling is an important influence, but those situations have not been identified. It may be that parents need to provide more direct assistance to support their children's physical activity. There was little evidence in the present review that mother's or father's physical activity was more likely to be related to the child's behavior. As mentioned above, the lack of consistent social correlates of children's physical activity was surprising.

Few physical environmental variables were studied, but there were consistent variables identified for both children and adolescents. Two of six frequently studied variables were consistently related for the younger group. Although it is obvious that young people must be active in some place, the findings regarding access to programs, facilities, and opportunities empirically validate the need for appropriate physical environment supports for youth physical activity. Providing these resources should become a policy goal for those interested in promoting youth physical activity. Results of studies assessing environmental variables also imply that it is important to get young children outdoors where they can be active.

There are numerous limitations to this review. The diversity of variables, measures, subject samples, and analysis strategies prevented a true meta-analysis. The present semiquantitative review required the establishment of definitions for consistency of association that are debatable, as are any arbitrary classifications. The categories of evidence and summary codes do provide, however, a relative assessment of the consistency of associations with physical activity. The present review focused on the consistency of reported associations and was not able to assess the strength of associations. To reduce the number of variables, similar constructs or specific measures of aspects of a general construct were combined into a single category. Only published papers in the English language were included. Although over 100 studies were reviewed, it is possible articles were missed in the retrieval process. The bias against publishing negative findings may have also affected the present results.

Strengths of the review include the systematic summary of over 100 published studies, the clear definitions of consistency of evidence, and the clear rules used in the coding of studies. This is the first review of correlates of youth physical activity that compared results for children and adolescents.

Conclusion and Recommendations

There are different recommendations for further research and action for each category of variables. The priority for variables classified as consistently associated with physical activity should be to apply these findings to improving interventions. The nonmodifiable demographic variables suggest subgroups of relatively inactive young people that need to be targeted for special intervention programs. Subgroups at risk for being inactive include girls, older adolescents, and those in minority ethnic groups. Modifiable variables identified in this review may be considered potential

mediators of youth physical activity, and interventions should be developed to change these variables through education, family programs, or environmental and policy change (1).

The variables whose associations with physical activity were classified as indeterminate should be subjected to more detailed study. This substantial group includes frequently studied variables such as child body weight and parent physical activity. Reasons for the inconsistent findings need to be explored. For example, there may be some subgroups of young people for whom parent physical activity is an important correlate, or there may be other variables that moderate the association.

Variables that have already been shown to be consistently unrelated to youth physical activity should be de-emphasized in future studies. These variables should not be targeted for change in interventions until additional research warrants it. Variables such as benefits, peer modeling, and socioeconomic status may show different results if better quality measures are used. For these variables especially, it is essential to use measures that are shown to be psychometrically adequate. It is likely that many variables are found to be unrelated to physical activity because of measurement error.

Some variables have been studied too few times to draw any conclusions, so more studies are needed to test variables that are understudied. Other possible correlates derived from theories, models, and creative thinking need to be evaluated for the ability to improve the explanation of youth physical activity. The purpose of this area of research should be to identify correlates of youth physical activity, further test promising variables in prospective studies, and then use the results to develop improved interventions that are rigorously evaluated.

Readers are encouraged to send the first author copies of appropriate papers that could be included in updates of this review.

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