International Journal of Physical Education, Sports and Health 2015; 1(6): 76-82

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 4.69
IJPESH 2015; 1(6): 76-82

www.kheljournal.com
Received: 15-05-2015
Accepted: 18-06-2015

Relationship between Health-related Fitness Knowledge and Physical Fitness

Rick C Ferkel, David F Stodden, Lawrence W Judge, Kent Griffin, Doug Hamman

Dr. Rick C Ferkel
Department of Human Performance, Campbellsville University, Campbellsville, KY 42718, United States

Dr. David F Stodden
Department of Physical Education and Athletic Training, University of South Carolina, Columbia, SC 29208, USA

Dr. Lawrence W Judge
School of Physical Education, Sport and Exercise Science, Ball State University, Muncie, IN 47306, USA

Dr. Kent Griffin
Department of Health and Human Performance, Texas State University, San Marcos, TX 78666, USA

Dr. Doug Hamman
Department of Curriculum and Instruction, Texas Tech University, Lubbock, TX 79409, USA

Correspondence:
Dr. Rick C Ferkel
Assistant Professor
Lead HPE Professor
Campbellsville University
Department of Human Performance 1 University Drive
UPO #793 Campbellsville, KY 42718, USA

Abstract
The purpose of this study was to examine the relationship between health-related fitness knowledge (HRFK), physical fitness (PF), and physical activity (PA) in a college-aged adult population. Participants included 191 (79 females, 112 males) college students from the southwestern United States. Health-related fitness knowledge was examined using the FitSmart Test, physical fitness was measured by seven fitness measurements that were normalized and combined as one factor, and self-report PA was assessed via the Leisure Time Exercise Questionnaire (LTEQ). Results indicated a significant relationship between health-related fitness knowledge and the physical fitness factor, $\Delta R^2 = .018$, $p = .037$; and health-related fitness knowledge and fitness without body composition factor (FNBC), $\Delta R^2 = .031$, $p = .009$. In conclusion, health-related fitness knowledge is associated with physical fitness levels in college-aged students. These findings point to the potential impact of health-related fitness knowledge as a supplementary predictor of health-related fitness.

Keywords: Health-related fitness knowledge, physical fitness, physical education, physical literacy, obesity

1. Introduction

Obesity levels, health-related diseases, and the rate of decline of overall wellness in society today have reached an all-time high [1]. Research findings suggest these changes are due to a lack of physical activity (PA) [2, 3, 4] and physical fitness (PF) [5, 6]. Research also suggests that this could be the first generation in history where children have a shorter lifespan than their parents due to high rates of childhood obesity [7]. As the health and economic impact of decreasing fitness, decreasing PA, and increasing obesity continue to emerge [8], successful interventions are needed to increase PF and PA levels.

Many interventions have been implemented to improve PA, PF, and overall health. These interventions have shown a significant relationship to improving PA and PF during the intervention and some longitudinal gains have been shown with PA but there is limited evidence in longitudinal gains in PF [9, 10]. It is imperative that interventions be discovered that have long lasting effects that enable individuals to continue and sustain PA while improving PF.

Previous research has indicated HRFK has a positive relationship with PA [11-13] and PF [14, 15] but these studies did not thoroughly investigate all three elements (HRFK, PA, and PF) in great detail with multiple measures. Other research investigating adult and adolescent physical education classes with an application component of cognitive (i.e., HRFK) learning and psychomotor dimensions (conceptual physical education) have found that individual adherence to PA has been prolonged when compared to individuals taking traditional physical education classes where only movement is emphasized [16- 19]. Previous studies also have indicated HRFK levels in students from elementary to college age is relatively low [20- 23], which includes students studying in health-related fields [24- 28].

With the current research available indicating a significant relationship between HRFK, PA, and PF and the positive relationship among applied (conceptual) physical education classes and long term adherence to PA, it could be inferred that HRFK may be an important contributor to an individual's motivation to implement and maintain a physically active and healthy lifestyle. Individuals equipped with the knowledge to apply concepts and processes into their everyday life to improve and maintain PF may demonstrate greater autonomy to choose and direct their PA [29, 30]. Initial levels and/or decreases in PA as children transition from childhood to adulthood [31-33] may result from a lack of HRFK. If an individual does not possess knowledge related to the importance of exercise and how to effectively structure a physical activity/fitness program, they may be more likely to discontinue PA as adults. The purpose of this study is to examine the relationship between health-related fitness knowledge (HRFK), physical fitness (PF), and physical activity (PA) in a college-aged adult population.

2. Materials and Methods

2.1 Sample

Participants were 191 (79 females, 112 males) college students, majority of non-Hispanic White students (70.2%), ages 18-25 enrolled at a university in the southwest United States. Individuals were recruited from personal fitness and wellness classes held at the university, classes included; weight training (*n* = 21), volleyball (*n* = 23), jogging (*n* = 37), basketball (*n* = 24), and walking (*n* = 86). All students attending the university were required to take a personal fitness and wellness class and the specific classes chosen in this study were to represent a variety of different activities, intensity levels, and a wide range of students with different lifestyles and interests. Participants provided informed consent approved by the universities human subjects committee.

2.2 Measures

A demographic and background questionnaire was given to participants to collect information on gender and race along with possible covariates including: college year (CYR), age, number of exercise science classes taken (ESS), years of high school sports (HSS), and socio-economic status (SES).

The five covariates (CYR, age, ESS, HSS, SES) chosen for this study were based on previous research that indicates education [34, 35], previous PA experience [36, 37], age [31, 32, 33, 38], and socio-economic status [39, 40] all contribute to increased PF and PA [41]. The covariates of college year and exercise science classes taken were used to evaluate both general (overall education) and specific (HRFK) education received and how it may associate with levels of PF and PA. The covariate of high school sports was used as a basis for examining the relationship between previous PA experience and current PF and PA levels [42].

Participants' HRFK was assessed by the FitSmart test [43]. The paper-pencil test of Form 1 was used and included 50 multiple-choice questions including each content area: (a) concepts of fitness, (b) scientific exercise principles, (c) components of physical fitness, (d) effects of exercise on chronic disease risk factors, and (e) exercise prescription. The test was graded by computer software provided by Human Kinetics [43]. Additional FitSmart content areas including nutrition, injury prevention, and consumer issues were not used as part of the final score as they did not specifically pertain to HRFK.

The Leisure time exercise questionnaire (LTEQ) [44] was used to assess self-reported PA. The LTEQ has high test-retest reliability (r = 0.74) and validity for cardiorespiratory endurance. Validity of the questionnaire was established against maximal oxygen uptake (VO^2 max) and established with body fat percentage predicting 69% of fit and 66% of unfit individuals [44]. Self- report PA was calculated in METs by the intensity level of exercise bouts (strenuous = 9 METs, moderate = 5 METs, mild = 3 METs) in an average seven day period. Moderate to vigorous physical activity (MVPA) was calculated adding the mean of moderate PA (MPA) (total MPA divided by valid days) to the mean of vigorous PA (VPA) (total VPA divided by valid days). By summing the two daily means, MVPA was derived.

The President's Challenge Adult Fitness Testing was utilized for the PF testing element of this study. The tests included: 1.5-mile run, push-ups, half sit-ups (crunches), sit-and-reach test, and body mass index assessments (BMI). Additional measures of fitness also included vertical jump as a measure of musculoskeletal power and waist circumference. A vertical jump power index was made to evaluate leg power by factoring in the weight of the participant. The power index equation is the "square root of weight * square root of the vertical jump height" [45]. Waist circumference was used in conjunction with BMI as recommended by the American College of Sports Medicine to determine overall health risks of body fat.

The Fitness construct was comprised of the five specific physical domains of health-related fitness (muscular strength, muscular endurance, flexibility, cardiovascular endurance, and body composition). To develop one fitness construct the fitness measures were normalized and then added together to create the composite Fitness variable. The normalization of the variables was conducted by the mean being subtracted from the observation and the difference being divided by the standard deviation, giving each measure a mean of 0 and standard deviation of 1. Before being added to the Fitness variable, the normalized scores of the 1.5-mile run, BMI, and waist circumference were multiplied by negative one because of their inverse effect on positive and negative fitness outcomes [46]. Based on the premise that health-related fitness levels are an indicator of functional and long term health [47], the comprehensive construct of Fitness, as produced by the seven fitness measures (push-ups, half-sit-ups, sit-and-reach, vertical jump power index, 1.5-mile run, BMI, and waist circumference) was used for statistical analyses [48].

Another fitness construct (FNBC) was developed using the same normalizing process and all the same elements of the Fitness construct except with no body composition (BMI and waist circumference). The rationale to examine two different fitness constructs was predicated on the idea that nutrition, diet, and other weight control variables were not factored into this study. Since these elements were not investigated, it is viable to say that body composition could be a misleading variable in overall fitness when considering HRFK. Research also indicates being fit while being overweight can still be a deterrent of chronic diseases compared to being unfit and lean or overweight [49]. These data provided appropriate rationale to investigate the concept of fitness with and without body composition.

2.3 Statistical Analysis

Data analysis was conducted using SPSS. Preliminary statistical analyses were conducted to test for data normality, skewness, and homogeneity of variance after data were cleaned; results indicated all assumptions were met. Descriptive statistics were calculated to numerically describe the data (e.g., examine distributions, examine outliers, etc.) and to describe the sample (e.g., age, race, education) (see Table 1).

Pearson's bivariate correlations among all dependent, independent, and possible covariates were examined to gain preliminary insight on the relationship among all variables. Multivariate analysis of variance's (MANOVA) were run to give a more thorough understanding of the data set. The dependent variables used for the MANOVA's were HRFK, Fitness, FNBC, and SRPA. The individual independent variables used in the analysis included gender, high school sports (HSS), and the Personal Fitness and Wellness (e.g., volleyball, basketball) class taken during data collection.

Sequential regressions were run with HSS and HRFK. The sequential regressions were run based on the preliminary investigation of correlates to PF and PA.

3. Results

The participants in this study had a mean age of 20.3 and college year of 2.6 (junior), with 84% playing a high school sport for at least one year and 60% playing for all four years. Mean fitness scores from this sample, compared to normative data provided by the Cooper Institute [50], indicated fitness scores were generally poor to very poor, excluding push-ups. Only male (M = 29.61) and female (M = 20.78) push-ups were above the 40th percentile (Fair rating). Data from this study indicated that 53% of students were overweight (BMI 25.0–29.9 kg/m^2) or obese (BMI ≥30.0 kg/m^2), which differs greatly from research that indicates 30% of college students are overweight or obese [51] (see Table 2).

The HRFK averages aligned with previous research indicating average scores of 70% or below [24, 25, 28]. Mean scores for males (67.5%) and females (66.7%) showed no significant difference.

Self-report PA data indicated the sample for this study was above recommended weekly averages of 36 METs (females M = 48.52, males M = 63.30). The weekly recommended average of 36 METs was based off of the minimum of 150 minutes of moderate-intensity physical activity (MPA) or 75 minutes of vigorous-intensity physical activity (VPA) a week or a combination of the two [52].

Pearson's bivariate correlations were calculated to evaluate possible relations among variables (see Tables 3 and 4). Out of the anticipated covariates of high school sport years (HSS), exercise sport science classes (ESS), college year (CYR), age, and socio-economic status (SES), HSS was found to have the strongest correlations with PF and PA. High school sport years correlated with SRPA, r = .194, p = .007, Fitness, r = .337, p < .001, Fitness with no body composition (FNBC), r = .414, p < .001, and multiple fitness measures. The covariates college years and age both had a significant negative correlation to Fitness, r = -.146, p = .044; r = -.161, p = .026 respectively, but did not correlate with FNBC or SRPA.

After evaluation of the MANOVA data analysis, there were no meaningful differences found between the independent variables and HRFK. The particular personal fitness and wellness class taken during data collection or gender did not affect participants HRFK.

Regressions (results in Table 5, 6, 7) were run using the predictor variable of HRFK on fitness variables. HRFK explained 1.8% of the variance for Fitness, 3.1% for Fitness with no body composition, and was not significant with SRPA. The results from the regression analyses indicate that HRFK contributed to the prediction of fitness variables, but did not contribute to self-reported physical activity.

3.1 Tables and Figures

Table 1: *Demographic Statistics of the Population of Study*

Variable	N	Percentage
Age		
18	24.0	12.6
19	45.0	23.6
20	39.0	20.4
21	41.0	21.5
22	23.0	12.0
23	19.0	9.9
College Year		
Freshmen	22.0	11.5
Sophomore	46.0	24.1
Junior	47.0	24.6
Senior	48.0	25.1
Other[a]	6.0	3.1
Variable	N	Percentage
Race/Ethnicity		
White	134.0	70.2
Hispanic	32.0	16.8
Black	17.0	8.9
Other[b]	8.0	4.1

Note: [a] Fifth year senior or beyond. [b] Any other race or ethnicity.

Table 2: *Descriptive Statistics of Health-Related Fitness Knowledge (HRFK), Fitness Measures, and Physical Activity Levels by Gender*

	Females		Males	
Variable[a]	**Mean**	**SD**	**Mean**	**SD**
HRFK (%)	66.70	9.07	67.48	10.38
SRPA (METs)	48.52	26.39	63.30	30.38
Push-ups	20.78	12.62	29.61	14.38
Curl-ups	23.04	11.46	28.24	10.84
Power Index	29.81	5.22	39.80	5.45
Sit & Reach (cm)	32.57	8.56	26.27	7.80
Run (minutes)	17.47	3.23	13.82	3.03
BMI	26.12	5.52	26.60	5.05
Waist Cir. (cm)	87.17	14.30	89.41	12.62

Note: SRPA = self-report physical activity. MVPA = moderate to vigorous physical activity. cm = centimeters. [a] n = 79 females and 112 males for all variable except MVPA. [b] n = 34 females and 30 males.

Table 3: *Correlations Table for Health-Related Fitness Knowledge, Physical Activity Measures, Fitness Measures, and Covariates*

Variables	HRFK	SRPA	MVPA	Fitness	HSS	ESS	C Yr.	SES
HRFK	1.00							
SRPA	.035	1.00						
MVPA	.084	.258*	1.00					
Fitness	.151*	.270**	.292*	1.00				
HSS	-.004	.194**	-.440	.337**	1.00			
ESS	.062	.083	.082	.024	.165*	1.00		
C Yr.	.167*	.116	-.218	-.146*	.076	.313**	1.00	
SES	-.045	-.022	.173	.015	.095	.014	.139	1.00
Age	.134	.040	-.205	-.161*	.080	.325**	.667**	-.092
Push-ups	.146*	.333**	.212	.677**	.409**	.073	-.023	-.083
Curl-ups	.240*	.099	-.026	.530**	.211**	-.014	.009	-.196**
LPI	.102	.205**	.147	.123	.304**	.073	.051	-.104
S & R	.051	.002	.095	.471**	.073	-.053	-.123	.114
Run	-.047	-.352**	-.314*	-.667**	-.398**	-.088	.030	-.021
BMI	-.017	-.155*	-.086	-.566**	.013	-.015	.152*	-.019
WC	.001	-.163*	-.150	-.683**	-.067	-.002	.177*	-.034

Note: HRFK = Health-related fitness knowledge. SRPA = Self-reported physical activity. MVPA = Moderate and vigorous physical activity. HSS = High school sport years. ESS = Exercise sport science classes. C Yr. = College year. SES = Socio-economic status. LPI = Leg power index. S & R = Sit and reach. Run = 1.5-mile run. BMI = Body mass index. WC = Waist circumference. [a] p = .054. * p < .05. ** p < .01.

Table 4: *Extended Correlations from Table 3 for Health-Related Fitness Knowledge, Physical Activity Measures, Fitness Measures, and Covariates*

Variables	Age	PU	CU	LPI	S&R	Run	BMI	WC
Age	1.00							
Push-ups	-.009	1.00						
Curl-ups	-.007	.419**	1.00					
LPI	.188**	.378**	.221**	1.00				
S & R	-.150*	.081	.173*	-.202**	1.00			
Run	-.047	-.541**	-.260**	-.393**	-.016	1.00		
BMI	.165*	-.156*	-.087	.357**	-.082	.439**	1.00	
WC	.243**	-.312**	-.121	.329**	-.164*	.439**	.894**	1.00

Note: PU = Push-ups. CU = Curl-ups. LPI = Leg power index. .S & R = Sit and reach. Run = 1.5-mile run. BMI = Body mass index. WC = Waist circumference. HRFK = Health-related fitness knowledge. SRPA = Self-reported physical activity. MVPA = Moderate and vigorous physical activity. HSS = High school sport years. ESS = Exercise sport science classes. C Yr. = College year. SES = Socio-economic status. * $p < .05$. ** $p < .01$.

Table 5: *Sequential Regression Analyses with the Model of High School Sport Years and Health-Related Fitness Knowledge Predicting Fitness*

Variables	Fitness (DV)	1	2	*B*	β	sr^2 incremental
1 HSS	.34**	1.00		.85	.338	.114**
2 HRFK	.15*	-.004	1.00	.06	.152	.023**
					Intercept = -6.577	
Mean	.00	2.89	67.16	R^2	.137**	
SD	3.96	1.57	9.84	ΔR^2	.128**	
				R	.370**	

Note: * $p < .05$. ** $p < .01$.

Table 6: *Sequential Regression Analyses with the Model of High School Sport Years and Health-Related Fitness Knowledge Predicting FNBC*

Variables	Fitness (DV)	1	2	*B*	β	sr^2 incremental
1 HSS	.41**	1.00		.81	.415	.171**
2 HRFK	.19**	-.004	1.00	.06	.191	.037**
					Intercept = -6.326	
Mean	.00	2.89	67.16	R^2	.208**	
SD	3.96	1.57	9.84	ΔR^2	.200**	
				R	.456**	

Note: FNBC = Fitness variable with no body composition. * $p < .05$. ** $p < .01$.

Table 7: *Sequential Regression Analyses with the Model of High School Sport Years and Health-Related Fitness Knowledge Predicting SRPA*

Variables	Fitness (DV)	1	2	*B*	β	sr^2 incremental
1 HSS	.19**	1.00		3.66	.194	.037*
2 HRFK	.04	-.004	1.00	.11	.036	.002
					Intercept = 39.323	
Mean	.00	2.89	67.16	R^2	.039*	
SD	3.96	1.57	9.84	ΔR^2	.029*	
				R	.197*	

Note: SRPA = Self-report physical activity. * $p < .05$. ** $p < .01$.

4. Discussion

This study was among the first to comprehensively investigate the relationship between health-related fitness knowledge (HRFK) and physical fitness (PF). The findings from this study, though small, indicate that HRFK predicts PF levels. When investigating PA, the findings of this study found no significant relationship between HRFK and PA among participants, but some notable and promising differences were identified among the female participants. Among these participants, HRFK did appear to be more closely related to levels of physical activity, but caution should be taken in over interpretation of this finding due to data limitations of participants. Results from this study along with others do suggest that if individuals are able to increase their HRFK, they will have a greater opportunity to improve their fitness levels.

Possible rationale on why the significant relationship between HRFK and the fitness variables were not larger along with the lack of relationship with HRFK and PA may be explained by two factors which both point to a possible developmental trajectory for the importance and influence of HRFK. First, the number of participants who took part in high-school sports was very high. With the large number of participants in this study participating in HSS, their skill levels and their desire to continue in recreational sports activities (e.g. intramurals) could still be present. These developed skill sets and fitness levels obtained through participation in high-school sports provided a basis for individuals to continue to successfully engage in PA into their collegiate years [48]. This minimizes the potential role that HRFK might play in fitness decisions and status.

Second, the affordances of the college environment may also minimize the relationship between HRFK, physical activity and physical fitness. The availability of many different PA opportunities provided in the college environment allows for maintenance of PA without necessarily needing a foundational base of HRFK. Physical activity has been found to decrease during the college years and continues to decrease as individuals' age. However, the accessibility of many different programs and PA opportunities provided to college students can possibly diminish the differential impact of HRFK compared to adults beyond the college age span. Instead, an older adult population has a lifestyle in which work, family, and other responsibilities require the majority of time and energy [41]. At this developmental stage of life, HRFK could possibly play a more vital role because the opportunity for sports and the availability of leisure time for various physical activities is diminished. Acquiring HRFK could provide the individual autonomy required to be successful in improving PF and PA.

The current findings of this study are consistent with many other studies indicating that HRFK is relatively low among college-aged students as well as the K-12 population. These results indicate that many college students do not possess adequate HRFK that may assist in the promotion of continued health-related fitness and PA behaviors. This is a concern, not only for college-aged individuals, but also points to the information that high school students are being taught, or not taught, in their physical education and health classes. If students do not have the proper knowledge, it may be more difficult for them to truly understand aspects of fitness and how they may apply this knowledge in future physical activity. The relationship between HRFK and ESS classes (includes all classes taken at the college level in exercise science, physical education, and personal fitness and wellness) taken by college students in this sample was analyzed to investigate the importance of ESS classes on HRFK. Interestingly, results indicated that there was no correlation between the number of ESS classes taken and HRFK, as well as no mean differences between the individual number of classes taken (range of 0 to 4) and HRFK. These findings indicate that students taking college-level courses that include some aspect of HRFK content and principles (44% of the sample) did not have higher HRFK then students not taking the classes. However, this does not take into consideration if HRFK was improved (i.e. knowledge learned) because of these classes. The fact that ESS classes do not seem to be developing students' HRFK may be a concern for the field. The very individuals that are being educated to teach and apply fitness knowledge to others in some area of exercise science (e.g., personal trainers, physical education teachers) may not have the knowledge or skills to adequately provide/teach HRFK. These results parallel those from previous research with pre-service physical education teachers who demonstrated a lack of adequate HRFK [24, 25, 28] and allied health students HRFK [26].

The limitations of this study are important to note. First, the sample in this study was not representative of 18-25 year old adults in the United States and in general the entire adult population. The sample was limited to only college students, thus, findings from our college population cannot be generalized to the entire adult population. Second, as stated earlier, the sample consisted of a majority of students that participated in high school sports. With so many participants involved with high school sports within the last five years overall fitness levels and activity levels can be skewed as previous PA experience could be the main factor in overall PF and PA results. With already higher PF levels and an environment welcoming opportunities to continue in sport, HRFK is not necessary to design, develop and cultivate PF and PA levels. Thirdly, using only one self-report questionnaire can limit a complete understanding of individuals PA levels. Implementing multiple PA measures, including an objective PA measure (e.g., accelerometers), would be a better indicator of true PA levels. Lastly, the sample of participants with which this study was conducted exhibited a restriction in the range of HRFK making analysis of variance techniques particularly ineffective. It is understood that the scores reflected in this study are congruent with previous scores but being limited to lower scores does not allow for a thorough investigation and delineation of the relationship higher HRFK has with PF and PA.

5. Conclusions

Health-related fitness knowledge is associated with PF levels in college-aged students, and these findings point to the critical nature of HRFK even among the youngest and most active group of adults. It seems likely HRFK would be even more important as adults advance in age. By evaluating the research of HRFK and its relationship to PF and PA along with the longitudinal PA gains and adherence from conceptual physical education classes, a picture is painted showing the importance of having applied fitness knowledge that can be implemented in everyday life. As physical educators, higher academia educators and researchers, and exercise science and health professionals, it is imperative that we are able to give individuals the tools to have the autonomy to continue on in lifetime physical activity and fitness. Getting individuals active and moving while they are with us is very important but being able to educate and equip individuals to be able to develop and implement activity on their own holds a lifetime of value. Future research should continue to examine links between HRFK and fitness among adults in various stages of the life span.

6. References

1. Centers for Disease Control and Prevention (CDC). State indicator report on physical activity, 2010 national action guide. Retrieved Sep. 14, 2010, from http://www.cdc.gov/physicalactivity/downloads/PA_State_Indicator_Report_2010_Action_Guide.pdf
2. Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE *et al.* The effectiveness of interventions to increase physical activity. A systematic review. American Journal of Prevention Medicine. 2002; 22(4):73-107.
3. Lee I, Shiroma E, Lobelo P, Puska P, Blair S, Katzmarzyk P. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. The Lancet 2012; 380(9838):219-229.
4. Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: the evidence. Canadian Medical Association Journal. 2006, 174 (6). doi:10.1503/cmaj.051351.
5. Duvigneaud N, Matton L, Wijndaele K, Deriemaeker P, Lefeve J, Philippaerts R *et al.* Relationship of obesity with physical activity, aerobic fitness, and muscle strength in Flemish adults. Journal of Sports Medicine and Physical Fitness. 2008; 48(2):201-210.
6. Dwyer T, Costan MG, Schmidt MD, Ukoumunne OC, Ponsonby OT, Raitakari OT *et al.* Decline in physical fitness from childhood to adulthood associated with increased obesity and insulin resistance in adults. Diabetes Care 2009; 32:683-687.
7. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J *et al.* A Potential Decline in Life Expectancy in the United States in the 21st Century. New England Journal of Medicine. 2005; 352(11):1138-1145.
8. Cawley J, Meyerhoefer C. The medical care costs of obesity: An instrumental variables approach. Journal of Health Economics. 2012; 31(1):219-230.
9. Hillsdon M, Foster C, Thorogood M. Interventions for promoting physical activity. Cochrane Database Systems Rev. Jan 25, 2005.
10. Lai SK, Costigan SA, Morgan PJ, Lubans DR, Stodden DF, Salmon J *et al.* Do school-based interventions focusing on physical activity, fitness or fundamental movement skill competency produce a sustained impact in these outcomes in children and adolescents? A systematic review of follow-up studies. Sports Medicine. 2014; 44:67-79. DOI:10.1007/s40279-013-0099-9.
11. Dilorenzo TM, Stucky-Ropp RC, Vander Wal JS, Gotham HJ. Determinants of exercise among children: A longitudinal analysis. Preventive Medicine 1998; 27(3):470-477.
12. Ferguson KJ, Yesalis CE, Pomrehn PR, Kirkpatrick MB. Attitudes, knowledge, and beliefs as predictors of exercise intent and behavior in school children. Journal of School Health. 1989; 59(3):112-115.
13. Thompson A, Hannon JC. Health-related fitness

knowledge and physical activity of high school students. Physical Educator 2012; 69(1):71-88.
14. Liang MT, Dombrowski HT, Allen TW, Chang CO, Andriulli J, Bastianelli M *et al.* Do medical students' knowledge and attitudes about health and exercise affect their physical fitness? Journal of the American Osteopathic Association. 1993; 93(10):1020-1020.
15. Williams SM, Phelps D, Laurson KR, Thomas DQ, Brown DD. Fitness knowledge, cardiorespiratory endurance, and body composition of high school students. Biomedical Human Kinetics 2013; 5:17-21. DOI: 10.2478/bhk-2013-0004
16. Adams TM, Brynteson P. A comparison of attitudes and exercise habits of alumni from colleges with varying degrees of physical education activity programs. Research Quarterly for Exercise and Sport. 1992; 63:148-152.
17. Dale D, Corbin CB. Physical activity participation of high school graduates following exposure to conceptual or traditional physical education. Research Quarterly for Exercise and Sport. 2000; 71:61-68.
18. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW. Blair SN. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: A randomized trial. The Journal of the American Medical Association. 1999; 281:327-334.
19. Jenkins JM, Jenkins P, Collums A, Werhonig G. Students perceptions of a conceptual physical education activity course. Physical Educator. 2006; Retrieved October, 9, 2009, from http://findarticles.com/p/articles/mi_hb4322/is_4_63/ai_n29321573/?tag=content;col1
20. Desmond SM, Price JH, Lock RS, Smith D, Stewart PW. Urban black and white adolescents' physical fitness status and perceptions of exercise. Journal of School Health. 1990; 60:220-226.
21. Keating XD, Chen L, Guan J, Harrison L, Dauenhauer B. Urban minority ninth-grade students' health-related fitness knowledge. Research Quarterly for Exercise and Sport. 2009; 80(4):747-755
22. McCormick J, Lockwood P. College student perception of wellness concepts. Physical Educator 2006; 63:78-103.
23. Placek JH, Griffin LL, Dodds P, Raymond C, Tremino F, James A. Middle school student's conceptions of fitness: The long road to a healthy lifestyle. Journal of Teaching in Physical Education. 2001; 20:314-323.
24. Barnett BE, Merriman WJ. Knowledge of physical fitness in prospective physical education teachers. Physical Educator 1994; 51:74-77.
25. Losch SH, Strand B. An analysis of the knowledge and fitness levels of physical education teacher education majors. Research Quarterly for Exercise and Sport 2004; 75:A-73.
26. Miller MG, Berry DC. Health-related physical fitness knowledge of student allied health professions. Evaluation & the Health Professions 2000; 23:305-317.
27. Miller MG, Housner L. A survey of health-related physical fitness knowledge among pre-service and in-service physical educators. Physical Educator 1998; 55:176-184.
28. Petersen B, Byrne H, Cruz L. The reality of fitness for pre-service teachers: What physical education majors "know and can do". Physical Educator, 2003; 60(1):5-18.
29. Biddle SJH, Nigg CR. Theories of exercise behavior. International Journal of Sport Psychology. 2000; 31:290-304.
30. Landry JB, Solmon MA. Self-determination theory as an organizing framework to investigate women's PA behavior. Quest, 2002; 54:332-354.
31. Caspersen CJ, Pereira MA, Curran KM. Changes in physical activity patterns in the United States, by sex and cross-sectional age. Medicine & Science in Sports & Exercise. 2000; 32(9):1601-1609.
32. Nader PR, Bradley RH, Houts RM, McRitchie SL, O'brien M. Moderate to vigorous physical activity from ages 9 to 15 years. Journal of the American Medical Association. 2008; 300(3):295-305.
33. Sidney S. Physical fitness and activity levels decline substantially as we reach middle age. The Medical News. 2007; 19:55.
34. Barnes PM, Schoenberg CA. Physical activity among adults: United States 2000. Advance Data: From Vital and Health Statistics, 2003, 333. Retrieved Aug. 26, 2010, from http://www.cdc.gov/nchs/data/ad/ad333.pdf
35. Centers for Disease Control and Prevention (CDC) & President's Council on Physical Fitness and Sports. Healthy People 2010: Physical Activity and Fitness, 2010, Retrieved, Aug, 26, 2010, from http://www.healthypeople.gov/document/html/volume2/22physical.htm
36. Malina R. Tracking of physical activity and physical fitness across the lifespan. Research Quarterly for Exercise and Sport. 1996; 67:48-57.
37. Taylor WC, Blair SN, Cummings SS, Wun CC, Malina RM. Childhood and adolescent physical activity patterns and adult physical activity. Medicine & Science in Sports & Exercise. 1999, 118-123.
38. Shaw BA, Spoane LS. Examining the association between education Level and physical activity changes during early old age. Journal of Aging and Health. 2008; 20(7):767-787.
39. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. Social Sciences and Medicine. 2002; 54(12):1793-1812.
40. Stamm H, Lamprecht M. Structural and cultural factors influencing physical activity in Switzerland. Journal of Public Health. 2005; 13(4):203-211.
41. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults? Participation in physical activity: review and update. Medicine & Science in Sports & Exercise, 2002, 34(12).
42. National Center for Education Statistics (NCES). What is the status of high school athletes 8 years after their senior year. 2005; Statistics in Brief. Retrieved Apr, 13, 2011, from http://nces.ed.gov/pubs2005/2005303.pdf.
43. Zhu W, Safrit M, Cohen A. The national health-related physical fitness knowledge test: FitSmart test user manual (high school edition). Champaign, IL: Human Kinetics, 1999.
44. Godin G, Shepherd R. A simple method to assess exercise behavior in the community. Canadian Journal of Applied Sport Science. 1985; 10:141-146.
45. Stodden DF, Galitski H. Longitudinal effects of a collegiate football strength and conditioning program. Journal of Strength and Conditioning Research. 2010; 24:2300-2308.
46. Stodden DF, Gao Z, Langendorfer SJ. Goodway JD. Dynamic relationships between motor skill competence and health-related fitness in youth. Pediatric Exercise Science 2014; 26(3):231-241.

dx.doi.org/10.1123/pes.2013-0027
47. Centers for Disease Control and Prevention (CDC). Overweight and obesity. Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion, 2009; Retrieved Oct, 16, 2009, from http://www.cdc.gov/obesity/childhood/index.html
48. Stodden DF, Langendorfer S, Roberton MA. The association between motor skill competence and physical fitness in young adults. Research Quarterly for Exercise and Sport. 2009; 80(2):223-229.
49. Lee CD, Blair SN, Jackson AS. Cardiorespiratory fitness, body composition, and all-cause and cardiovascular disease mortality in men. American Journal of Clinical Nutrition. 1999; 69(3):373-380.
50. Cooper Institute. Common questions regarding physical fitness tests, standards and programs for public safety. 2010; Retrieved Sep, 20, 2010, from http://www.cooperinstitute.org/education/law_enforcement/documents/LAWCommonlyAskedQuestions.pdf
51. American College Health Association National College Health Assessment. Spring 2005 reference group data report (Abridged). Journal of American College Health. 2006; 55(1):5-16.
52. US. Department of Health & Human Services. 2008 physical activity guidelines for Americans, 2008, Retrieved Sep, 14, 2010, from http://www.health.gov/paguidelines/guidelines/default.aspx