*Original Research*

# Relation of Income and Education Level with Cardiorespiratory Fitness

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ABSTRACT

***International Journal of Exercise Science 8(3): 265-276, 2015.*** While there is strong evidence measuring the association between leisure time physical activity (LTPA) and socioeconomic status (SES) there are limited data on the relationship between cardiorespiratory fitness (CRF) and SES. The purpose of this cross-sectional study was to examine differences in CRF and LTPA between household income and individual education in young adults. A sample of 171 (males n=98, female n=73) young adults participated in the University of Pittsburgh-Physical Activity Study. Participants completed CRF testing. Demographic characteristics were assessed via interviewer administered standardized survey and LTPA was assessed using the interviewer administered Modifiable Activity Questionnaire. Participants were grouped by income and education level. Analysis of variance and general linear modeling was used to compare LTPA and CRF between groups. There were no differences in CRF between income levels ($p$=0.126) or education levels ($p$=0.990) for the total sample. There were no differences in LTPA between income levels ($p$=0.936) or education level ($p$=0.182) for the total sample. Results suggest that neither income nor education levels are indicators of CRF in this sample of young adults. Other environmental, sociological, or familial health mediators may have a strong effect on CRF in young adult males and females.

KEY WORDS: Cardiorespiratory fitness, educations level, income level

## INTRODUCTION

In recent years, governmental agencies and professional organizations have issued many public health messages that promote regular physical activity (PA) participation (12, 15, 16, 22). These messages are often used as a core component of weight management and public health strategies. However, accelerometer data from the

National Health and Nutrition Examination Survey (NHANES) indicate that only approximately 9.6% of the US population currently meets the US Physical Activity Guidelines (45). In addition, multiple investigations have found that participation in PA is unevenly distributed across populations. Since participation in PA has been shown to decrease over the life span with the steepest decline occurring in young adulthood (43), investigating these different distributions in PA in young adults may provide important information for public health interventions.

Household income, individual education level, social status, and occupation are indices of socioeconomic status (SES). Previous studies have found that, independent of lifestyle factors, individuals with high SES have up to a fourfold greater leisure-time PA (LTPA) participation than their lower SES counterparts (19, 32, 34, 41, 42). Specifically, income and education have been linked independently to prevalence of overweight and obesity, health-related quality of life, morbidity, and participation in LTPA (33, 44, 47). Shaw and colleagues found that those with higher education levels tend to be more active during leisure-time than lower educated individuals, and lower educated individuals are more likely to experience a comparatively greater decline in LTPA throughout life (39). Epidemiological research has identified LTPA as a key health behavior protecting against the development of obesity (21).

While previous research determining the association of LTPA to income and education are relatively clear, studies have shown cardiorespiratory fitness (CRF) to be a better predictor of all-cause-mortality and cardiovascular disease than LTPA alone (4, 30, 35). These studies show that being unfit is associated with higher mortality risk even among individuals who report participating in LTPA (30, 35). Furthermore, high CRF provides protection against mortality regardless of excess body weight or the existence of metabolic syndrome (10, 11, 26). Unlike LTPA (which is often measured using a questionnaire), CRF can be determined objectively using a laboratory based measure of oxygen consumption. CRF can account for 70-80% of the variance in self-reported PA levels (5, 31), and when CRF is determined by oxygen consumption it is less prone to misclassifications (3).

Previous studies suggest that differences in cardiovascular disease and all-cause morbidity/mortality between different SES groups have grown progressively larger (32-34). These studies indicate a lower SES status is associated with a higher tendency to participate in unhealthy behaviors (32, 35, 36). Furthermore, occupation and social status have been linked to behaviors associated with increased CRF (23, 24, 37). However, there is conflicting evidence regarding independent relation of income and education to CRF in healthy young adults. Recent reports suggest that differences in health behaviors associated with specific indices of SES are shrinking (2, 20). Zhang et al., reported that, in comparison to data from the 1970s, the difference in obesity prevalence between SES groups decreased to 14% by the year 2000. Both Fitgerald and Shmueli concluded that there was no statistical difference in CRF when individuals were stratified by income level after controlling for other SES variables (18, 42), while Kaewthummanukul and Brown found inconclusive results regarding the impact of education on LTPA (25). Although CRF may have a genetic component, LTPA habits are the primary determinant of CRF in adults provided optimal levels of intensity, frequency and duration are achieved as part of each LTPA session. Sub-threshold PA (i.e. intensities lower than moderate/vigorous) may not provide a physiological overload stimulus to promote CRF gains. Thus, low levels of LTPA may result in comparatively lower CRF levels and subsequent increased risk of mortality (6, 7). The primary aim of this investigation was to examine the independent relation between two measures of SES (i.e. total household income and individual education level) and both CRF and LTPA in healthy young adults. We hypothesized that those individuals in the lower education and income groups would have comparatively lower LTPA and subsequently have lower CRF compared to those of higher income and education groups.

## METHODS

*Participants*

Cross sectional data from participants in the Pittsburgh Physical Activity Study (PittPAS) were used for this secondary analysis. Briefly, PittPAS was Phase III of the Epidemiology of Physical Activity from Adolescence to Adulthood study; a 20-year longitudinal investigation that followed the subject cohort from adolescence to adulthood. In Phase III, participants who completed a questionnaire previously were re-contacted and asked to visit the laboratory to examine psycho-physiological mechanisms that might explain: (a) current level of physical activity (PA) participation and (b) spontaneous change in PA participation. A total of 228 young adults reported for laboratory exercise testing during Phase III. Fifty-seven participants did not meet the criteria for a valid peak oxygen uptake assessment and therefore were removed from the present analysis. One hundred and seventy-one young adults (98 males, 73 females, age 27-33 yrs.) that completed a valid peak treadmill test and demographic questionnaires were included in the present analysis. Approval for this study was obtained from the University of Pittsburgh Institutional Review Board, including informed consent by all participants.

*Protocol*

Prior to the laboratory treadmill test participants completed an interviewer administered standardized survey to assess age, income, education, race and ethnicity.

Prior to laboratory testing, participants were instructed not to eat for 4-6 hours or engage in heavy exercise 24 hours prior. Peak oxygen uptake was determined by indirect calorimetry (ParvoMedics TrueOne 2400, Sandy, UT) using a multistage Bruce protocol administered on a Trackmaster TMX425C treadmill (Newton, KS). The protocol consists of 3-minute stages as follows: Stage 1) 1.7 mph at a 10.0% grade; Stage 2) 2.5 mph at a 12% grade; Stage 3) 3.4 mph at a 14% grade; Stage 4) 4.2 mph at a 16% grade; Stage 5) 5.0mph at a 18% grade (9). Measures of heart rate (HR) ($b \cdot min^{-1}$), Rating of Perceived Exertion (RPE), and oxygen consumption ($ml \cdot kg^{-1} \cdot min^{-1}$) were obtained at the end of each stage and post-exercise. RPE was measured by the Adult OMNI-Walk/Run RPE Scale (OMNI-RPE). The peak exercise test ended with volitional termination due to exhaustion of the participant. Testing was considered a valid

**Table 1**. Descriptive data for the total sample and by sex.

| | | **Males (n=98)** | **Females (n= 73)** | **Overall (n=171)** |
|---|---|---|---|---|
| Weight | | 186.2 ± 36.4 | 152.5 ± 25.6 | 171.8 ± 36.2 |
| Height | | 70.1 ± 3.0 | 64.4 ± 2.4 | 67.6 ± 4.0 |
| BMI | | 26.6 ± 4.7 | 25.9 ± 4.0 | 26.3 ± 4.4 |
| Age (yrs.) | | 29.8 ± 1.0 | 29.4 ± 1.0 | 29.6 ± 1.0 |
| $VO_2$peak ($ml \cdot kg^{-1} \cdot min^{-1}$) | | 42.5 ± 7.9 | 34.0 ± 6.3 | 38.9 ± 8.4 |
| LTPA ($min \cdot wk^{-1}$) | | 406.1 ± 349.8 | 239.2 ± 290.7 | 335.7 ± 335.6 |
| Race (%) | White | 86.0 | 83.6 | 85.0 |
| | All Other Races | 14.0 | 16.4 | 13.9 |
| Income Level (%) | <25K | 23.0 | 23.3 | 23.1 |
| | 25-39K | 25.0 | 27.4 | 26.0 |
| | 40-59K | 33.0 | 24.4 | 29.5 |
| | ≥60K | 18.0 | 23.3 | 20.2 |
| Education (%) | High School/GED | 19.0 | 6.9 | 13.9 |
| | Trade School/ Some College | 33.0 | 23.3 | 28.9 |
| | College Graduate | 32.0 | 38.4 | 34.7 |
| | Postgraduate | 16.0 | 30.1 | 22.0 |

Note: Values are Means ± SD or percentages; K-dollars in thousands; GED- General Educational Diploma, BMI- Body Mass Index, $VO_2$peak= peak oxygen consumption, LTPA= Leisure Time Physical Activity. Weight n= 96 males, 72 females. Height n= 97 males, 73 females. BMI n= 96 males, 72 females

$VO_2$peak test when participants met any one of the following criteria: 1) < 2.1 $ml \cdot kg^{-1} \cdot min^{-1}$ increase in $VO_2$ with increasing exercise intensity; 2) HR ± 5 $beats \cdot min^{-1}$ of the age predicted maximum (defined as 220 – age); 3) Respiratory Exchange Ratio ≥ 1.10; or 4) a OMNI-RPE of ≥ 9.

LTPA was assessed using the interviewer administered Modifiable Activity Questionnaire (MAQ) for adults (1). The MAQ was developed by Kriska (1990) as an accurate and practical instrument to measure adolescent PA in epidemiologic research (1). Past-year activities were assessed to obtain the most accurate representation of the individual's usual activity level. This approach recognizes that activity surveys with a short time frame may not reflect normal PA over a longer period because of seasonality, acute illness, or other causes of short-term variability of activity (29). Change in the pattern, type, or amount of LTPA was also assessed by using a semi-structured one on one interview to obtain in-depth responses. The semi-structured format involved predetermined, open-ended, guiding questions that were sequentially expanded based on participants' previous responses. The guiding questions were designed to assist participants in reflecting on their PA experiences, the meaning of those experiences, and the various factors influencing their experiences.

*Statistical Analysis*
Comparisons between means were evaluated using analysis of variance (ANOVA). Data were analyzed by whole sample and re-analyzed to explore, possible sex effects. An exploratory analysis was performed on all variables. In cases where the data were not normally distributed Box-Cox transformation was used to achieve normalization. Where transformation was performed ($VO_2$peak and LTPA), the transformed data sets were normal as determined by a Shapiro-Wilk test. Results are presented in back transformed values. For the education category, participants were grouped as reporting High School/GED, Trade School/Some College, College Graduate, and Postgraduate degree. For the income category, participants were grouped as reporting <\$25K, \$25K-\$39K, \$40K- \$59K, and ≥\$60K per year. Chi-square test was performed to determine whether the groups were equally distributed. Brown and Forsythe's test was performed to test the homoscedasticity of variances. When the assumption of homoscedasticity was violated or groups had unequal sample sizes Welch's ANOVA was used. General linear modeling (GLM) was used to assess the effects of race and ethnicity between group differences in LTPA and $VO_2$peak. Statistical significance was determined at 0.05 alpha level, and all analyses were performed using SAS Software, version 9.4 (SAS Institute Inc., Cary, NC).

**RESULTS**

Two hundred twenty-eight individuals participated in laboratory based exercise testing during Phase III, and 171 individuals (75.9%) successfully completed all outcome assessments. Sample demographics are presented in Table 1.
Due to the data not being normally distributed, the data underwent transformation. After transformation, $VO_2$peak between income levels and education levels for the total sample (W= 0.99, p= 0.60; W=0.99, p=0.66, respectively), men (W= 0.98, p= 0.08; W=0.99, p=0.66, respectively), and women (W= 0.98, p= 0.54; W=0.98, p=0.29, respectively) were normally distributed. Additionally, LTPA between income levels and education levels for the total sample (W= 0.98, p= 0.06; W=0.98, p=0.07, respectively), men (W= 0.98, p= 0.08; W=0.98, p=0.08, respectively), and women (W= 0.97, p= 0.07; W=0.97, p=0.11, respectively) were normally distributed. A summary of the ANOVA results presented in back transformed values for LTPA and $VO_2$peak are presented by group and sex in Table 2 and Table 3.

There was no statistically significant difference in $VO_2$peak between income levels ($p$=0.126) when all participants were analyzed (Table 2). When the sample was reanalyzed stratified by sex, there were no differences in $VO_2$peak between income levels for men $p$=0.431) or women ($p$=0.343). Additionally, there were no statistically significant differences in $VO_2$peak in the total sample between education levels ($p$=0.990, Table 3). Reanalysis stratified by sex showed no significant difference in $VO_2$peak between education levels for either the men or women ($p$=0.660 and p=0.096, respectively).

For the total sample, there were no statistically significant differences in LTPA

**Table 2.** Peak oxygen consumption and leisure time physical activity by income level for men, women, and total sample.

| | Income Groups | | | | | | | | Between-Group differences |
|---|---|---|---|---|---|---|---|---|---|
| | <25K | | 25-39K | | 40-59K | | ≥60K | | |
| | n | Mean ± SD | n | Mean ± SD | n | Mean ± SD | n | Mean ± SD | *p*-value |
| *Total Sample* | | | | | | | | | |
| $VO_2$peak ($ml \cdot kg^{-1} \cdot min^{-1}$) | 40 | 39.3 ± 8.5 | 44 | 37.4 ± 6.6 | 50 | 38.9 ± 9.0 | 35 | 39.5 ± 8.9 | 0.126 |
| LTPA ($min \cdot wk^{-1}$) | 38 | 349.6 ± 396.0 | 44 | 343.1 ± 327.4 | 50 | 314.0 ± 238.0 | 35 | 312.1 ± 251.5 | 0.936 |
| *Men* | | | | | | | | | |
| $VO_2$peak ($ml \cdot kg^{-1} \cdot min^{-1}$) | 23 | 43.9 ± 7.1 | 24 | 40.3 ± 6.0 | 32 | 42.6 ± 9.0 | 18 | 41.9 ± 8.2 | 0.431 |
| LTPA ($min \cdot wk^{-1}$) | 23 | 401.4 ± 455.2 | 24 | 482.2 ± 380.3 | 32 | 382.6 ± 266.2 | 18 | 396.8 ± 299.7 | 0.509 |
| *Women* | | | | | | | | | |
| $VO_2$peak ($ml \cdot kg^{-1} \cdot min^{-1}$) | 17 | 33.0 ± 5.7 | 20 | 33.9 ± 5.5 | 18 | 32.2 ± 3.7 | 17 | 37.0 ± 9.1 | 0.343 |
| LTPA ($min \cdot wk^{-1}$) | 15 | 275.1 ± 396.0 | 20 | 176.3 ± 327.4 | 18 | 192.1 ± 97.4 | 17 | 222.4 ± 149.6 | 0.807 |

Note: K-dollars in thousands, $VO_2$peak= peak oxygen consumption, LTPA= Leisure Time Physical Activity.

in between income levels ($p$=0.936, Table 2). When stratified by sex, no significant differences in LTPA were identified between income levels for men ($p$=0.509) or women ($p$=0.807). Additionally, there were no statistically significant differences in LTPA between education levels for the total sample ($p$=0.182). When stratified by sex, there were no differences in LTPA between education levels for men ($p$=0.539) or women ($p$=0.676, Table 3).

Regression models that included education, race and ethnicity were used to examine factors associated with LTPA and $VO_2$peak. Race was not significantly associated with change in LTPA or $VO_2$peak across income levels ($p$=0.702, $p$=0.198; respectively or education levels ($p$=0.718, $p$=0.189; respectively). In addition, participant ethnicity was not significantly associated with change in LTPA or $VO_2$peak by income ($p$=0.129, $p$=0.643; respectively) or education group ($p$=0.271, $p$=0.672; respectively).

## DISCUSSION

The primary aim of this investigation was to examine the independent relation between total household income and individual education level and both CRF

**Table 3.** Peak oxygen consumption and leisure time physical activity by education level for men, women, and total sample.

| | Education Groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | High School/GED | | Trade School/ Some College | | College Graduate | | Postgraduate Degree | Between-Group differences |
| | n | Mean ± SD | n | Mean ± SD | n | Mean ± SD | n | Mean ± SD | *p*-value |
| *Total Sample* | | | | | | | | | |
| $VO_2$peak (ml·kg$^{-1}$·min$^{-1}$) | 23 | 39.0 ± 7.4 | 50 | 38.7 ± 8.9 | 60 | 38.9 ± 8.1 | 37 | 38.7 ± 8.6 | 0.990 |
| LTPA (min·wk$^{-1}$) | 22 | 510.8 ± 509.1 | 50 | 332.0 ± 275.3 | 60 | 315.3 ± 245.1 | 37 | 244.4 ± 226.7 | 0.182 |
| *Men* | | | | | | | | | |
| $VO_2$peak (ml·kg$^{-1}$·min$^{-1}$) | 18 | 40.6 ± 7.2 | 33 | 42.8 ± 8.0 | 32 | 42.0 ± 7.1 | 15 | 43.9 ± 9.5 | 0.660 |
| LTPA (min·wk$^{-1}$) | 18 | 541.6 ± 519.2 | 33 | 396.4 ± 297.5 | 32 | 394.4 ± 288.2 | 15 | 345.3 ± 314.6 | 0.539 |
| *Women* | | | | | | | | | |
| $VO_2$peak (ml·kg$^{-1}$·min$^{-1}$) | 5 | 33.0 ± 5.3 | 17 | 30.7 ± 3.2 | 28 | 35.2 ± 7.7 | 22 | 35.1 ± 5.9 | 0.096 |
| LTPA (min·wk$^{-1}$) | 4 | 372.2 ± 505.4 | 17 | 206.8 ± 173.0 | 28 | 224.9 ± 141.4 | 22 | 175.6 ± 99.5 | 0.676 |

Note: GED- General Educational Diploma, $VO_2$peak= peak oxygen consumption, LTPA= Leisure Time Physical Activity.

and LTPA in healthy young adults. The results indicated that CRF and LTPA of young adult males and females did not differ between varying levels of total household income and education. Additionally, when variables were analyzed separately by sex stratification, there were no differences in CRF or LTPA between income and education levels. However due to the small sample size and cross-sectional study design, these results should be interpreted with caution.

While strong evidence supports the relationship between LTPA and SES (41, 42), the independent relationship of CRF and LTPA to education and income individually is less clear. Our findings of no significant difference in CRF and LTPA across education levels is in agreement with results from several cross-sectional studies (2, 13, 14, 25, 36, 38, 46). For example, Cleland et al. found no clear relationship between individuals who were active/fit in youth and in adulthood having persistently low education (parental low education as a child and low education as an adult) and persistently high education (parental high education as a child and high education as an adult) (13). In addition, both Desmond et al. and Pender et al. reported no association between LTPA and education (14, 36). While, positive associations of LTPA and higher education levels have been reported in males and females separately (8), and in females only (17), Bauman et al. determined that education was a correlate to individual

LTPA but not considered a determinant of LTPA (2).

Similarly, we found no differences in CRF or LTPA across different levels of household income. Our observation of no significant difference across income levels is similar with other reports in the literature. Previous investigations have not clearly concluded that income is an independent determinant of physical activity (2, 17, 25, 36, 38, 46). Shmueli and colleagues, demonstrated that there was no relationship between CRF and those in either a lower or high income category in a sample of 8,471 adults (42). In addition, Fitgerald et al., found there was no statistical difference in CRF by income level after controlling for ethnicity (18). Some investigations suggest the association of SES to LTPA and CRF is driven by individual occupational type rather than income alone (2). Desmond et al. reported that male workers with higher incomes participated in more occupational PA and less LTPA compared to workers with lower incomes (14). Kirk and Rhodes determined that occupation was directly associated with LTPA, with other factors such as job strain, working hours, and overtime mediating the association (27).

There is evidence to suggest that differences in CRF and obesity between SES groups are on the decline, and SES may not be a major indicator of disease risk in the near future (48). Recent reports from Brazil show that between the years 2002 and 2007, the level of physical activity increased significantly in individuals of low income while staying the same in individuals of higher income. This suggested a shrinking in the gap of physical activity performed between individuals of differing SES, and a shift in PA social pattern (20, 28). A systematic review of PA correlates noted a positive association between SES and LTPA in countries of low and middle income while concluding there were inconsistent or inverse results from high-income countries (2). This suggests other more influential environmental and social factors rather than SES might explain increased energy intake or decreased energy expenditure recently observed in population groups stratified by income and/or education level. These factors could be responsible for similarities between the groups. Identifying these factors and focusing on PA that improves CRF and decreases body weight would be useful.

Although we found no significant mean differences across categories of education and income, there was a comparatively low level of CRF observed throughout the sample. When this sample's CRF test levels were compared to the ACSM normative values of $VO_2$max with specific reference to age and sex, the only group that was above the 50$^{th}$ percentile for CRF was men with a postgraduate education. However, it should be noted that the group median value for this male/postgraduate group was still only at the 55$^{th}$ percentile. As for the remaining socioeconomic categories, the group median fell at or under the 50$^{th}$ percentile rank. This indicates that a lower than average CRF level was measured for all socioeconomic groups. This low level of fitness across income and education groups for both males and females could contributed to an increased risk of cardiovascular disease, high cholesterol, hypertension and all-cause-mortality (5, 40). All groups reported participating in over 150 min of LTPA per week. Therefore, the low levels of CRF that were measured across all groups may be a result of a comparatively lower intensity of their LTPA performed on a weekly basis. It is likely that the intensity of the activities did not reach the stimulus threshold to improve CRF. If LTPA is not performed at intensities above the overload training threshold (i.e. 60-70%$VO_2$max), improvements in CRF will likely be minimal. Future studies should address associations of CRF and LTPA focusing on fitness level, amount of leisure time PA and intensity of PA. In addition, using objective measures (i.e. accelerometry) of PA may help in determining the total volume of movement performed throughout the day.

The present findings add to the small number of studies that focus on the relation between CRF and both income and education in young adults. However, an important limitation of the current study, as well as other studies on this topic, is the use of a cross-sectional design which may have influenced the results. In addition, the original study was not designed specifically to detect differences in CRF or LTPA between income or education levels. Furthermore, the study included a high representation of white males and females (86%), making generalization of results to minority populations difficult. Moreover, with the small overall sample size and distribution between males and females not being equivalent, outcomes and sex effects should be interpreted with caution. Future studies should examine the relation of CRF with income and education across a broader age range and more diverse minority groups.

High CRF is associated with a reduced risk of chronic disease and all-cause-mortality, and in some cases considered a better predictor of health risks than LTPA. The present results reported no differences in CRF between income or individual education levels in groups of young adult males and females. According to the ACSM normative table for percentile values of maximal aerobic power, a majority of the groups had CRF levels lower than the 50th percentile. Due to the relatively low CRF shown by all income and education groups in this study, developing interventions to increase their CRF by engaging in regular, moderate to vigorous intensity PA is critical.

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